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A NEW GERMAN MILITARY BALLOON.

INTERESTING experiments have lately been tried on the Tempelhof Field, near Berlin, with a new balloon that is quite different in form from other balloons. It consists of a great cylindrical balloon, at one end of which are fastened two little round balloons. Under this end hangs the car, which is fastened by many ropes to the main balloon. By a simple arrangement the car can be made to hang from the opposite side. The disagreeable back and forth swinging of the balloon and the car is prevented by the peculiar form of the new captive balloon and the arrangement of the little satellites, which can be controlled from the car by means of ropes. With all air ships known heretofore the taking of observations was rendered very difficult and sometimes impossible by this constant change in the position of the balloon and the car, but the new balloon remains quite stationary, even when the wind is high.

All day long it was being drawn down and let up again, so that all of the officers might have an opportunity to test the instruments in the basket or car. For this purpose the ring above the car was connected, by means of a hawser, with a wagon belonging to the air ship department, carrying a roller on which the rope could be wound. There were about 3,280 feet of hawser in the air. If the balloon was to be lowered, a pulley was fastened to the hawser near the wagon, from which about thirty ropes hung down, and these ropes were held by a corresponding number of soldiers. The men marched toward the balloon slowly drawing it down. When a fresh load of passengers had climbed into the basket the men ran back toward the wagon and the balloon rose quickly. Hundreds of people were attracted by the experiments, for the balloon floating high in the air was visible from many places in Berlin.—Illustrirte Zeitung.

EXPERIMENT WITH A NEW CAPTIVE BALLOON ON THE TEMPELHOF FIELD, NEAR BERLIN.
FROM A SKETCH BY C. HOSANG.

THE uses to which aluminum is put are constantly extending. Thus far three entire regiments of the Prussian Guards are furnished with big drums made of the new metal.

HIGH SPEED ON RAILWAYS.

By W. H. WESTON, M.E.

THE increasing demands upon the railways of the country are all in the direction of speed, economy and safety. Safety to the public means economy to the railroad, and economy to the railroad means economy to the general public. The elements that allow and promote high speed are indirectly also those which give economy and safety.

Economy means time saved, least wear and tear on rolling stock, roadbed, etc., commensurate with the amount of work done. Attaining high speed is not so much a matter of trouble with the engines as it is with the roadbed, rails, crossings, grades, etc. A meanly constructed, crooked line of road is the principal hindrance to all the elements of economy and fast running, and everything desired for the present and the future. High speed on a crooked, uneven line of road is simply impossible. Therefore, on most of the railways continuous fast running of heavy trains for any distance is beyond possibility; that is, with the roads in their present state. These lines, with their many sharp curves and heavy grades, offer very great hindrance to the demands of future travel. It is unreasonable to expect—as the majority of people do—that a railroad that is so built as to run through one point and avoid another within a few hundred feet can be used for 70 miles an hour speed. That irregular local lines are needed cannot be denied, but it should not be expected that 70 miles an hour can be attained on them. These two elements cannot be secured on one line.

In order to secure high speed throughout the length of a road: First, the line must be straight and level. Second, the rails must be heavy, at least 100 pounds. Third, the roadbed must be properly built and have the best of ballasting. Fourth, the sections must be so kept that all joints and rail lengths will be up in perfect line. Fifth, a road must be double tracked for its entire length, and a fast train must not have freight and local trains to interfere with it; that is, it must have unrestricted freedom of the whole line at its time of running. If a train must stop at a half dozen stations in a run of a hundred miles, and be delayed on a single line by having to wait at turnouts for passing trains that are late half the time, it should not be expected that an average high speed for the run can be secured, even in case the roadbed is in first-class condition. But it usually is expected that a train can be hauled through at quick time, even against the disadvantages of the above mentioned hindrances. And also usually on the poorest of roadbeds, both as to first construction in line and material and also in maintenance.

Locomotives are turned out from railroad builders' shops that are, generally speaking, fully capable of what they are planned for—to haul heavy trains and to haul fast trains. Most engine builders, motive power superintendents and master mechanics know how to bring out an engine for its special work. Ordinarily, locomotives are, when given a proper chance, capable of doing much more and much better work than they usually are allowed to do on account of the poorest of means being given them to do their work on. And they are very soon rattled to pieces and worn out by running over a line of track that is often disgraceful.

Poorly constructed lines of road are not always the fault of the civil engineers in charge, but are caused by the want of a sufficient amount of money expended by the management. Taking everything into account, the average dividend for twenty years' running would, in most cases, be greater on a road costing $60,000 per mile than if it were built on an expenditure of $40,000, with light iron, heavy grades and poor ballasting. There are very often to be found examples of lines built irregularly with many sharp curves in them, because it was desired by poor judgment to avoid a cutting at one point or a fill at another. And the result is that now when fast trains are wanted they cannot be had, simply because the road is not fit to run them on. Yet the trial is often made to provide high speed on these railways, and because it does not succeed the failure is entirely charged to the engines, when in reality there is no failure on the part of the locomotive.

In the first place, a proper road must have a line

that is practically straight from one end to the other, and by this is meant one that has nothing sharper than a two-degree curve in it. Such a line could readily be built, if so desired, and at the same time touch all the special points and towns or parts of towns that it was thought advisable to pass. The large amounts of money that are spent every year by existing railroad companies to straighten their lines at various points is sufficient evidence that crooked first construction is a vast disadvantage, and that satisfactory and paying results can only be had by avoiding such construction.

When a cut is made, it would be far better to spend a little more in proportion and bring it down to a true level. And this extra expense will always be made up entirely in a comparatively short time, if the road has a business that warrants it being operated. It may be argued that no steam is used in going down a grade, consequently a grade is no loss. But it will always take more steam to get any kind of a train up to the top of a hill than is saved in going down the other side, when compared to a run on a level. In thus speaking of grades, of course exception is not taken to those that are unavoidable, such as where there is a continual rise in the country along a line for a very long distance.

Next, there is no excuse for sharp hollows being left only half filled, while they might be brought up to a level easily, at the time of building, with but a slight excess in cost. Now, provided the line and level are all right, the next thing in construction is the ballasting. This should, for high speed, or, in fact, for any heavy work, be composed of stone. There is no material that has ever been tried that is practically as good for ballasting as broken stone. The advantages of this kind are numerous. In the first place, it remains in position longer and better than anything else will. Next, the drainage of such ballasting is perfect, or under ordinary circumstances can be made so. This is a great element in its favor, as it preserves the ties and gives a chance for a very much longer life of them; and the ties and iron when put in proper place and in good line, and level, will remain in position far longer than in any other material.

Of course, the cost of stone ballasting, in the first place, will be more than for common material, but in the working of a road for ten or twenty years, probably the stone ballasting is the cheapest; that is, as far as the latter is concerned, simply in itself; and when the saving on rails, ties and rolling stock is taken into account, it is far cheaper than any other ballasting. The first cost and the quality of broken stone will, of course, vary greatly in different localities. But there is scarcely a road where high speed is wanted but can secure this material if desired.

High speed demands heavy rails; and the safety of travel and a proper length of the life of rolling stock demand them. In regard to the actual weight of rails per yard, a 70-pound rail is far too light to be economically used on any prominent railway. A 100-pound rail is near to what should be used, although a 120-pound one would in a great many cases at present time be more economical still.

Switches require far more care in the selection, placing and maintenance than is given. Roads are numerous that have hardly a switch on them that is fit to run over at a high speed, on account of poor details, poor construction and not being taken proper care of. On a line that is to answer the requirements of the present time, every part of the roadway must be carefully and thoroughly looked after and kept continually at its best. When this is done on a road that is properly built, the engines will haul trains at high speed satisfactorily and economically. Give existing engines a proper road to run on, and they will do all that is wished for.—Nat. Car Builder.

THE INFLUENCE OF CIRCULATION ON EVAPORATIVE EFFICIENCY OF WATER TUBE BOILERS.*

By Mr. JOHN I. THORNYCROFT, F.R.S., Vice-President.

To obtain the highest evaporative duty from a given tube service, it is necessary that the contents of the tube should consist of, as far as possible, water only; and to attain this result the steam must have the freest possible egress from the tubes, and must also be carried from them by an energetic circulation of water in a constant direction. To some of the leading features which affect these conditions I would now call your attention. Considering the boilers shown in Figs. 1 and 2, if the pressure in the lower vessel—that is, at the bottom ends of the generating tubes—is due to the full depth water in the boiler, in addition to the steam pressure, then any reduction of density in the generating tubes will all be available for causing circulation; and thus any reduction to pressure to the lower vessel, below that due to the head of water in the boiler, is a direct loss to the energy of circulation, so that variations of this pressure are of great importance. These variations can be conveniently measured by a pressure column formed of a long gauge glass connecting the steam space of the upper vessel with the lower vessel. The difference of the water level in this glass from the water level in the upper vessel is a direct measure of any reduction of pressure in the lower vessel.

I have made experiments, taking observations from such pressure columns fitted to the boilers shown in Figs. 1 and 2, when they were working under different conditions. The rate of evaporation and steam pressure being varied for the several arrangements of boiler, which were: (1) Generating tubes delivering above water. (2) Generating tubes delivering below water. (3) Generating tubes delivering below water—without any special downtake tubes.

The curves given in diagram 3 show graphically the results of these experiments; the falls of pressure in the lower vessels are plotted as ordinates, and the rates of working as abscissæ. It will be seen that the rate of working has been taken up very high, probably more than double ordinary working, the object in doing this being to ascertain up to what rate each arrangement can be worked with safety. In the first series of curves, the results recorded are obtained from the boiler, Fig. 1, with the generating tubes delivering above water. It will be seen from the curve that, as the rate of working is increased, the pressure column falls slightly, and at an evaporation of 20 lb. of water per square foot of heating surface stands at 85 per cent. of the maximum; and by halving the working pressure the results are not sensibly changed.

The next series of curves is taken from the boiler, Fig. 2, which has the same heating surface, etc., as Fig. 1, but the top ends of the tubes deliver below water. It will be seen that the curves fall much more rapidly than the first series, and that by halving the working pressure, the pressure is distinctly reduced in the lower vessel.

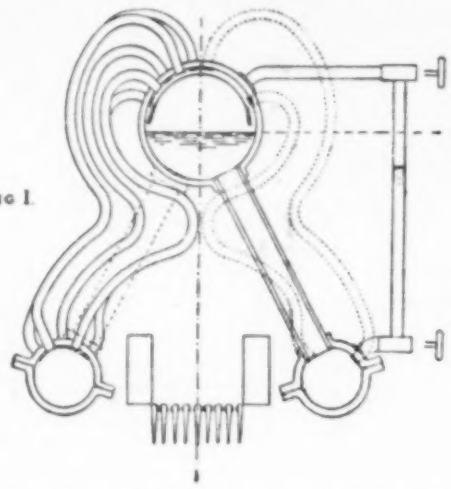


FIG. 1.

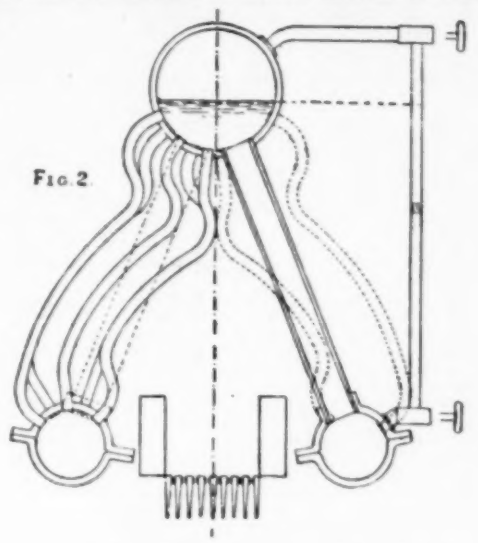


FIG. 2.

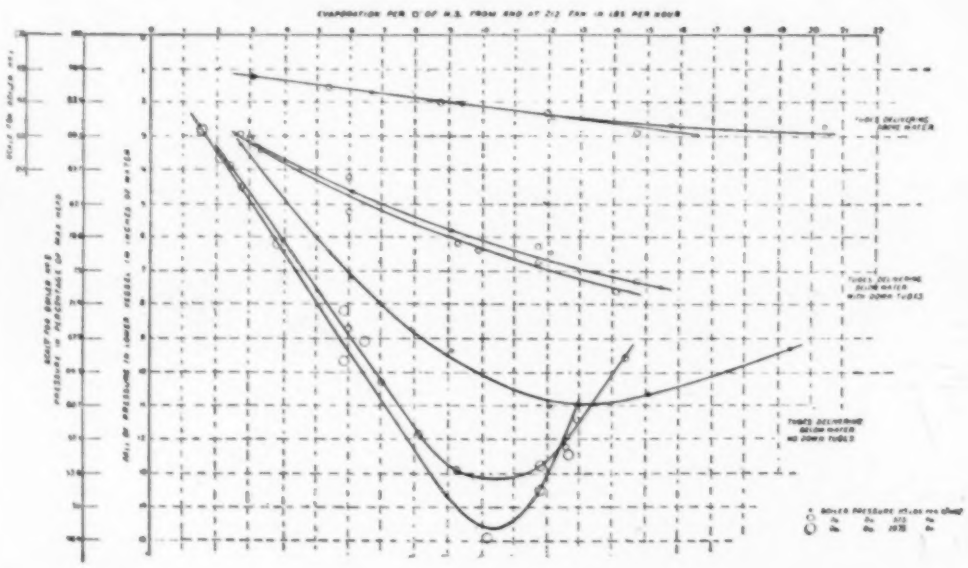
The third series was obtained from the boiler, Fig. 2, by plugging up the down tubes, so that some of the generating tubes had to act as down tubes, for the supply of the others; the feed water all being delivered into the upper vessel. In this case the character of the curves changes from the first two series very much. A diminution in pressure of working causes the pressure column to fall very much; in the case of the pressure being only 28·75 lb. per square inch absolute, it fell to about 46 per cent. of the maximum. The most important point, however, apart from this low pressure, but a result of it, is that for any given pressure a critical rate of working is arrived at when the pressure column begins to rise again with increased rate of working, thus showing an increased pressure in the lower vessel, caused by the steam being unable to get out at the top ends of the tubes fast enough, and so comes out at the bottom ends as well. It will be seen from the curves that the lower the pressure of working the sooner this critical point is arrived at, and I found that when the evaporation was pushed beyond this critical point the tubes were not safe from overheating; but, by taking the tubes intended for downtakes, and extending their upper ends above the water surface so that water could not go down, and the steam in the lower vessel could readily get away to the separator, it was possible to increase the rate of evaporation somewhat, inasmuch as the facility for the tubes getting rid of their steam was increased.

Contrasting the different conditions of working of the water tubes in the three series of experiments I have described, and noting what slight differences these conditions may necessitate in the design of a boiler, the nearness to success which a boiler intended for hard forcing may be, and yet fail, is clearly shown.

In conclusion, I would submit that the absence of special down tubes limits to a great extent the amount to which a boiler can be safely forced, and shows that to obtain the highest rate of working with safety and efficiency these special down tubes must not be neglected; and still further the tubes should deliver above water, as then the circulation, as I have previously shown, is double that when the tubes deliver below water. So that this rapid circulation is a most important condition for hard working.

* Institution of Naval Architects.

FIG. 3.



HOLDING POWER OF BRAKES AT HIGH SPEED.

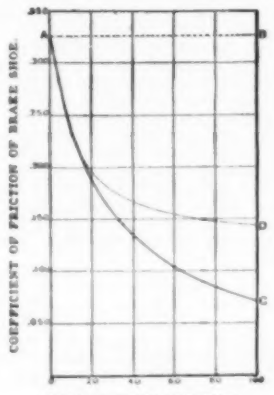
IN the admirable volume entitled "The Effect of Brakes upon Railway Trains," recently published by the Westinghouse Air Brake Company, is an interesting preface reviewing what is known at the present time about the friction of brake shoes in railroad service. Among other things, the preface gives a table showing the coefficient of friction of brake shoes as determined by the Westinghouse-Galton experiments. The table also gives a formula for the friction at different speeds which has constants or factors, which are derived from the results of the experiments by the method of "least squares," which is a plan used by mathematicians to reduce the variations and errors to a minimum. The formula practically coincides with the observed results up to about sixty miles an hour, which is the highest speed at which observations were made. Beyond this point, if the law that is indicated by the actual results and set forth by the formula, viz., that of the reduction of the friction as the speed increases, holds good, then the holding power of brake shoes at 100 miles an hour must be very small compared to what it is at ten miles an hour. According to this law, the holding power at 100 miles an hour is less than one-third of what it is at ten miles an hour and only one-half of what it is at forty miles.

It is not new information that brakes used on railroad trains have less holding power at high speed, as this has been known since the publication of the results of the experiments of Westinghouse and Galton, in 1878; but the fact that the maximum stopping power which can be applied with the present apparatus is very small at exceedingly high speeds has not been duly appreciated; and although several progressive railroad men and the Westinghouse Air Brake Company have done some important and useful work in developing the "high speed" brake, yet the necessity for such a brake is not as generally understood as might be supposed from the public character of the experiments. In the Railroad Gazette of May 25 last, page 373, it was shown how the saving of a few feet in the length of the stop would reduce enormously the force of a collision, and the experiment with the "high speed" brake on the Pennsylvania Railroad* is a practical illustration of what can be had in the way of increased safety for fast trains by providing some sort of brake apparatus so designed as to make the stopping power more nearly constant at different speeds. The saving in the distance from the point where the brakes were applied to the point of full stop in the case of the

* The Pennsylvania experiment was reported in the Railroad Gazette of April 13 last, page 268. While the comparative trials were not worth much for record, on account of improper adjustment of apparatus and the presence of conditions, such as wet rails and irregular supply of sand which could not be fairly estimated, there was no doubt of the main fact that the use of the pressure-release valve helped materially to shorten the stops. This appears from the paragraph near the bottom of page 269 in the article mentioned, where a saving of 28 per cent. in distance is shown.

Pennsylvania Railroad tests was considerable, and enough to warrant the construction and maintenance of special brake apparatus for important trains.

Probably a diagram like the one printed herewith shows more clearly the change in a series of results than a column of figures in a table. This diagram shows the change in the holding power of brake shoes at different speeds as determined by Galton and Westinghouse, and is practically the only data available at this time that is sufficiently reliable or complete to be used as a basis for the comparison of the holding power of brake shoes at different speeds. The curved line, A C, shows the reduction of the power available to stop trains with the present apparatus as the speed increases. The data for this was taken from the table in the preface of the Westinghouse Company's publication referred to above. The line, A B, indicates a uniform stopping power at all speeds, and that is what it is desirable to obtain in order to reduce the length of the stop to a minimum, and it is the object of the high-speed brakes to make the curved line, A C, coincide more nearly with the line, A B. Probably this is impossible; and, so far as is known now, about all that can be done is to raise the point, C, so that the curve of braking power may be perhaps something like A D. Even the small increase of braking power shown by the line, A D, will make a great difference in the length of the stop. The reason for this is, that to reduce the velocity of a train work must be done upon it and the stored energy reduced. This is done in the case of brakes by the friction of the brake shoes, and the energy taken out is represented by the product of the friction of the shoes and the distance run. Thus, if the friction of the shoes be 1,000 lb., and the train be run 100 ft., the stored energy of the train will be reduced by 100,000 foot pounds. At the higher speeds, the train runs a longer distance for a given reduction of speed than at slower speeds. The distance run in reducing the speed of a train from 100 to 50 miles an hour is much greater than that run during the remainder of the stop—that is, from 50 miles an hour to a standstill—and therefore a small increase in the braking power at high speed will reduce the length of the stop considerably.



The preface to the new publication of the Westinghouse-Galton experiments is very suggestive, and a comparison of the summary there given with the expected results from the M. C. B. Laboratory Brake Shoe Tests Committee cannot fail to be interesting. And if the committee's work corroborates the Westinghouse-Galton conclusions, we shall then have a good foundation on which to base the next step in air brake service, namely, to provide adequate control for high-speed trains, and to reduce the emergency stopping distance for a train running at 100 miles an hour to half a mile or less.—The Railroad Gazette.

[Continued from SUPPLEMENT, No. 976, page 15595.]

METHODS OF MINE TIMBERING.*

By W. H. STORMS, Assistant in the Field.

OVERHAND STOPING.

WHEN a working drift is driven along a vein in ore and it is the intention to "stope" out the ore, the character of the walls and the width of the vein or deposit must determine the method of timbering. If the walls be hard and firm, and the vein not more than 10 or 12 feet wide, posts are not absolutely necessary. Stulls of the proper length are placed with the lower end resting on the foot wall, or in a niche cut for the purpose, the upper end being placed against the hanging wall and driven downward until it stands at a few degrees above a right angle with that wall. (See Figs. 16 and 18.) When the foot wall has a greater inclination than the hanging wall, a support resting on the floor of the drift must be placed under the lower end of the stull. Should the foot wall have a less inclination than the hanging wall, the foot of the stull may be secured by driving in stout wedges from the upper side. Where the foot wall is sufficiently hard and firm, a niche in either case will answer as a secure rest for the lower end of the stull. Where the vein is more than 10 feet in width and additional support appears necessary, resort may be had to the plans shown in Figs. 19 to 29.

In case either wall, or both of them, is too soft to safely sustain stulls under the pressure of ore or waste to be piled upon them, a plate (usually a 2 or 3 inch plank) is inserted behind the stull on either wall or both, as may be necessary. (Figs. 17 and 25.)

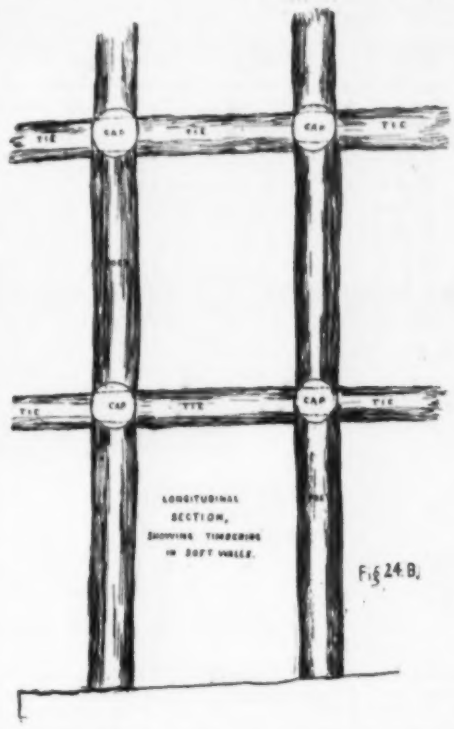
When the walls are very soft, and even with the use of plates, render timbering insecure, the stulls may be placed at right angles to the walls, the ends resting upon posts. Mining upward, the posts of each floor rest upon the stulls under foot and immediately above the posts on the floor below. In this manner a stope in soft walls may be carried to any desired height. (Fig. 24 A.) In such instances it is necessary to place longitudinal braces or "ties" reaching from cap to cap at right angles to the stull. These ties may be of smaller dimensions than the stull and post timbers.

The method shown in Fig. 19 may be employed where the vein exceeds 8 or 10 feet and when sticks sufficiently large to support the weight of ore or waste cannot be obtained. Fig. 20 may be employed in the same manner with a greater width of vein. Both of these instances presume considerable waste to result from mining, which will, to a great extent, fill the excavation. Fig. 23 affords a firm support to a stull in a wide place in the vein, and Fig. 22 the same in a still broader vertical vein. Fig. 25 shows how, in a vein of low dip and considerable width, a stull may be firmly supported to retain waste or ore coming down from the stope above. In soft vein and wall rock a substantial method of placing sill, stull and post is shown in Fig. 26.

Stulls are placed at distances ranging from 2½ to 6 feet, as may be required. On them are laid split lagging, forming a floor. As the miner stands on the floor thus improvised, he breaks down the ore, separating it from the waste, if there be any, and sending the ore into the "level" or main passageway below, allowing the waste to accumulate on the floor. The waste often occurs to such an extent that a portion of it also has to be sent to the surface. When this is the case, very little timber is required in the stopes. When, however, the quantity of waste is small, it is often necessary to build a temporary staging upon which to stand until a sufficient space is cut out above to admit of laying a second tier of stulls to sustain the floor. Floors are 6 to 8 feet apart and sometimes even more.

A passageway, called a "mill hole," "chute," or "slide," is left every 30 to 50 feet for the purpose of sending ore to the level below, as the work progresses upward. The distance between these slides is determined by the dip of the vein. They may be a greater distance apart in a steeply inclined vein than in one having a low angle of inclination. Rock will not run freely on a slope having a slope of less than 40 degrees, and more is preferable. In cases where the slope angle is low, it is a good idea to line the slide with plank to facilitate the delivery of the ore to the level beneath. In opening a stope between levels, the best method is to make a raise from level to level, building a loading chute at the bottom. Then at a short distance to one side (15 or 20 feet) a second raise is carried up about 15 feet and connected with the winze. From this point the stope is opened, the excavation being carried upward and the ore being passed down through the winze to the loading chute. As the floors are carried up a crib is built around the winze, keeping it constantly open. This plan secures economy of labor and affords the best obtainable ventilation. The stoping of ore continues to within a few feet of the level above, and is then discontinued for the time being, this mass of ore and that remaining within a few feet of the floor beneath being left to be taken out the last thing before abandoning this portion of the mine.

When ore is very rich it is the custom to blast or pick it down upon canvas or boards, keeping it separate as far as possible from the waste, the ore being sacked in the mine. The methods above described apply to overhand stoping, that is, excavating from a level upward.



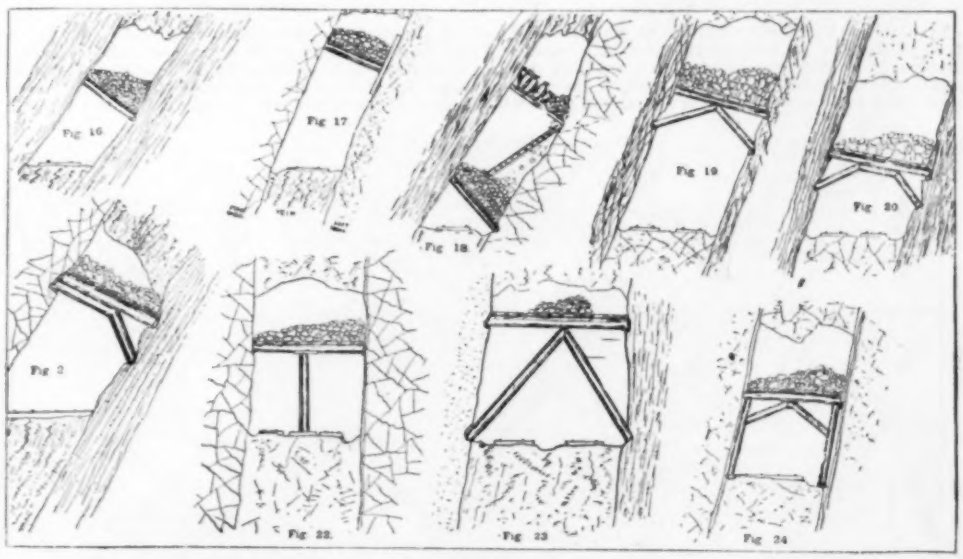
UNDERHAND STOPING

is the term use to indicate an operation the reverse of that just described, being the method by which the miner takes out the floor of his level and continues the excavation downward in a series of steps 7 or 8 feet in height. In this method it is best for the economical handling of the ore, for ventilation, and for drainage, to have established a connection by winze with the level next below, or it will be necessary to hoist all the ore and water from the stope to the level above. The waste, if there be any, is thrown on platforms or floors between the face of each floor and the winze, slide,* or chute. This method is not advisable except in narrow, rich veins.

Underhand stoping is not commonly followed, but may be recommended in working small veins of very rich ore. It requires usually more timber than overhand stoping, and the timber cannot be recovered as in the latter method.

CONNECTING LEVELS.

When stoping by the overhand system, on approaching the floor of the level above it is necessary, where posts and caps have been used, whether sills were used or not, to take some precaution to prevent the falling out of these timbers and the consequent caving of the filled stope above, should there be any. The plan adopted in the Bi-metallic Mine, near Phillipsburg, Montana, is the most expeditious and the safest. When ready to break through the floor under any particular sill or set of timbers, a stout piece of timber (sprag) is placed between the posts a few inches above the floor (at A) and wedged in hard with shingle wedges. A heavy stick of timber (B B) long enough to reach across three sets (kept on each level of the mine for this purpose) is lifted to the roof of the gangway, midway between the posts, one end being under the cap which forms a portion of the set of which the sill to be removed is also a part. This timber acts



* From Bulletin No. 2, California State Mining Bureau. Dr. J. J. Crawford, State Mineralogist.

* The term "ore slide" appears preferable to the word "chute," as conflict is thereby avoided with the word "ore shoot" as applied to a body of ore.

like a lever having a fulcrum at C, in the form of a post which supports it, the foot resting in the center of the drift on the sill, D. Wedges are driven in at E, making it firm and rigid. Wedges are then driven in at F and at C, and the rock beneath may then safely be extracted, the timber set, G G, being held in position, the superincumbent weight being transferred to the points D and E. As a matter of course the sill of the set G G will drop out when the rock upon which it has rested has been removed. The remainder of the set may then be connected with the timbers of the sets beneath in any manner the case requires.

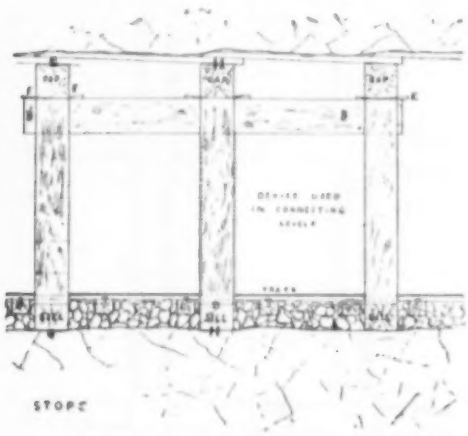
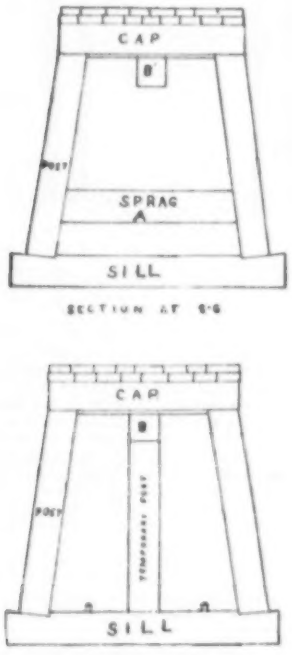


Fig. 30.



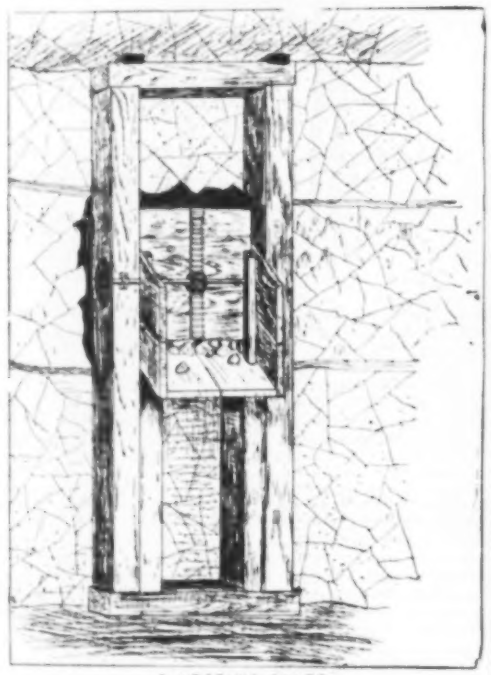


Fig. 31.

STRENGTH OF TIMBERS.

In placing stulls to sustain the weight of waste, or to store ore already broken, the size and number of timbers to be employed must be determined by the width of the vein and the height to which the waste or ore is likely to accumulate. It is considered to increase the number rather than the size of stulls. With good walls, stulls 7 feet in length, having a thickness of 12 inches, placed 30 inches apart, are calculated to sustain 60 feet of waste or broken ore in a vein standing at a high angle. After waste has remained in place for some time it settles, and in some instances becomes so firm as to retain its solidity after the stulls have fallen out or have been removed. This need not be expected in wide veins.

When it becomes necessary to quickly catch up settling stull timbers or caps, a stout post, which will just slip under the sinking timber, is placed in position and four stout wooden wedges, having the inclined planes sloping alternately in different directions, are driven in between the post and stull. This plan will recover the subsidence, if not too great, and permit of re-enforcing the timbers without losing ground.

SADDLE BACKS.

A peculiar method of timbering, known as the "saddle back," is in vogue in some portions of Colorado. It appears to do well in the lead-silver mines, having good limestone roofs and walls. It may be considered a modification of the "square set." It requires less timber and is far less substantial. It will not do in heavy ground. The details differ with the various conditions encountered, but the principles are those obtaining in all other timber systems—the application of resistance to pressure. The drawings illustrate one method of setting up the saddle back.

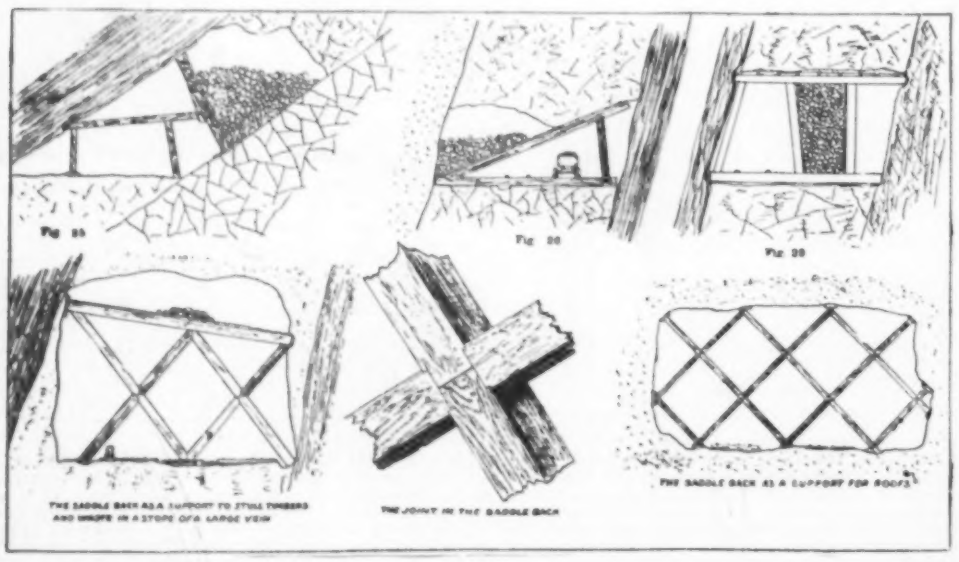


Fig 28
Fig 29
THE SADDLE BACK AS A SUPPORT TO STULL TIMBERS AND WASTE IN A STOPE OF A LARGE VEIN
THE JOINT IN THE SADDLE BACK
THE SADDLE BACK AS A SUPPORT FOR ROOFS

LOADING CHUTES.

The accompanying sketch shows a design for a loading chute or slide, though they are not always made as elaborate as represented in the drawing. The inclination of the bottom should exceed 30 degrees, ores that are soft and wet requiring the slide to have a greater pitch than those that are dry. Between the two upright posts, which reach from the floor of the drift to the roof or to stout stulls overhead, two short uprights are placed, and on top of them, reaching from one to the other, is laid a 4 × 6 scantling. The gate, furnished with ratchet and wheel and pinion, may be dispensed with, loose boards being substituted, which may be pried up, when desired, with a bar. It is well always to build loading chutes in a substantial manner, so that rebuilding may not be necessary. It is a wise plan to provide false sides and bottoms, which may be quickly renewed.

The posts supporting loading chutes are not always placed perpendicular. In steeply inclined veins it is sometimes desirable to set them inclining forward. In vertical veins they are built across the vein.

In square sets, ore bins are constructed within the sets and the chutes are attached to the caps or ties, being arranged at convenient distances from each other.

In some mines, as in the Golden Gate at Sonora, in Tuolumne County, large storage bins are constructed below the floors of the levels at the hoisting shaft, provided with a loading chute. The skip is stopped at the proper point and loaded. In this manner the necessity of waiting for cars, or loaded cars and men waiting for the skip, is obviated. In this mine loading chutes are provided on the several levels from the stopes overhead, as a matter of course, being constructed in the ordinary manner.

(To be continued.)

ELECTRIC TRANSMISSION OF POWER FOR MINING PURPOSES.

ONE of the most interesting cases of the electrical transmission of power for coal mining purposes in Europe has been completed and set in operation at the Decize Collieries, in the Nievre Department of France, and which are owned by MM. Schneider & Co. This installation is remarkable from the fact that diphase alternating currents are employed for the transmission, and diphase alternating current motors are used for reconverting the electrical energy into mechanical power at the different pits. In designing this plant the problem to be solved was to erect a central generating station for the distribution of electrical energy at the different pits where it could be utilized in electromotors for operating ventilating fans, hauling machinery, pumps and for lighting purposes. A general idea of what had to be accomplished is shown in the annexed table:

Site.	Distance from generating station. Yards.	Electrical machinery or lamps receiving the current transmitted.
1.—West.		
Puits des Chagnats	5,050	30 H. P. electric motor. *
Fendue des Lacets	3,466	" " *
Puits des Coupes	2,056	" " *
Puits des Zagots	1,084	Electric hauling machine of 15 H. P.†
2.—Generating Station.		
Various installations	—	Six arc and 100 incandescent lamps.‡
3.—East.		
Fendue des Marizy	1,300	30 H. P. electric motor and 24 arc lamps.§
Sorting and washing shops of the Pre-Charpin	2,400	500 incandescent lamps of 16 C. P.‡
Champvert	3,250	12 H. P. electric motor.‖

* Used for ventilating fan. † Inclined plane. ‡ Lighting. § Ventilating fan and lighting. ‖ Pumping.

The generating station is situated respectively at distances of from 3·1 miles and 1·86 miles from the extreme points which have to be supplied with current. It contains a battery of six boilers and two units (steam engines and dynamos), each of a capacity of 100 kilowatts; a further unit will shortly be laid down. The two units may be worked singly or in parallel. The engines are of the horizontal non-condensing type, running at 300 revolutions per minute, and driving the diphase alternators by means of belting. A notable feature in this connection is the fact that each electrical unit comprises a twin alternator, or in reality two machines, placed one at each end of the shaft, the driving pulley carrying the engine belt being arranged in the middle of the shaft. Of course, in a case like the present, where current is employed both for lighting and for power purposes, one of the circuits may become more loaded than another, and in this event the equilibrium must be established by varying the ratio of the electromotive forces. The arrangement adopted in the Decize installation allows of this being accomplished, as each of the two circuits having a distinct field, it is only necessary to vary the exciting current by means of rheostats to get the desired effect. The generators introduced are Zipernowsky 10-pole alternators, with revolving field magnets. The 10-field magnets are connected together in series, and the exciting current is led to them by means of two metallic rings carried on an extension of the driving shaft on the opposite side to that of the driving pulley—that is to say, on an outer extension of the shaft. Two ordinary brass brushes press upon these rings, to which the exciting current is furnished by a direct current dynamo. This latter machine is operated by a belt from the shaft of the alternator. At 900 revolutions a minute this direct current dynamo supplies the exciting current for the twin alternator, being between 25 and 30 amperes at 110 volts. The fixed armature of the alternators is formed of 10 coils, any one of which can be withdrawn and replaced with little trouble.

After passing through the switchboard, the current is transmitted mainly by means of overhead wires to the points of utilization, the only portion laid underground being toward the end of the principal line leading to the Chagnats pit. The wires forming the overhead line are of silicon-bronze, and are carried on porcelain insulators attached to poles 24 ft. high. The diameter of the wires constituting the principal line to the western part of the district is 6 mm., and 4 mm. in the case of the remainder of the line. It is noteworthy that the same poles carrying the transmission wires also support telephone wires, the latter being arranged

12 ft. from the ground. In order to counteract the effects of induction in the telephone wires, the line conductors are crossed at distances averaging 540 yards, and by this means the difficulty of understanding conversation along the telephone wires which use the earth as return has been overcome. The small portion of underground line forms a lead-covered cable, laid in a wooden conduit, as also does the telephone line for the same distance. Suitable lightning conductors are provided at the generating and distributing sub-stations and at intervals along the line. The electromotors at the sub-stations where the current is utilized for the different purposes mentioned in the table given above are of the same type as the generators. These diphase motors are easily set in operation, and are to all intents and purposes left to themselves for several hours together. The only attention they receive is the visit of an employe every six or eight hours to ascertain whether the motors are working properly. The sub stations are situated in the forest, and the facility of working on this system, as compared with the erection in each place of a boiler, steam engine and ventilating fan, is considered to be remarkable, apart from the question of the cost of transporting fuel.—Colliery Guardian.

HIGH SPEED VERTICAL ENGINES.

WE illustrate, from the Engineer, two forms of a high speed vertical engine, each being one of a series recently introduced and manufactured by Messrs. Ransomes, Sims & Jefferies, of Ipswich and London. The engine is of the open double-acting type, and has been specially designed for driving dynamos, fans, pumps, and other high speed machinery, either coupled direct or by belt. Before finally adopting the design shown, Messrs. Ransomes have carefully studied the special requirements of high speed engine users, and they have made costly experiments to ascertain the best manner in which these requirements can be met. The engine under description is the result of their experience; a considerable number have already been supplied, and are, we are informed, giving great satisfaction. The general design of the engine will be understood from the illustration, but it may be built with the valve chest and fly-wheel reversed in position.

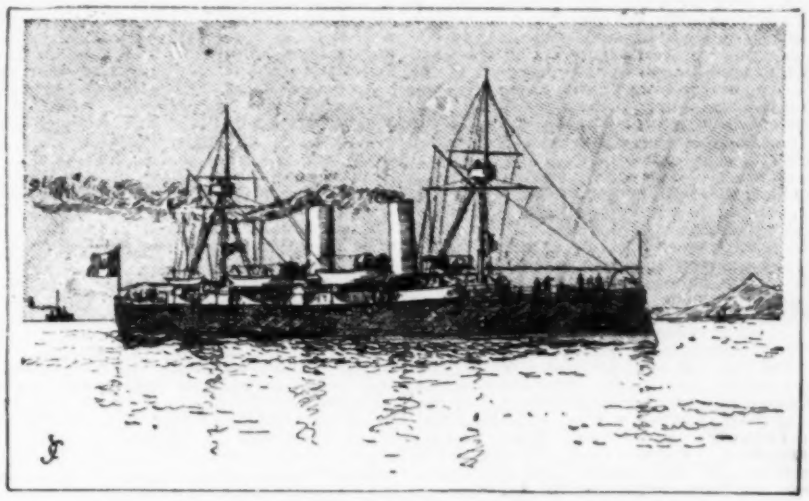
In calculating the strengths and wearing surfaces of the various parts, a very high boiler pressure and an ample margin of safety has been allowed for. The engines may be worked direct from the boilers of triple expansion engines without risk of breakdown or heating. All reciprocating parts are accurately balanced. The crosshead is of cast steel, and the gudgeon is so fitted that the loosening of one nut and a slight tap will release it, and admit of the examination of the brasses. The crosshead gudgeon and the crank-pin are both of very large diameter, and the width of each of these bearings is equivalent to twice the diameter; the shaft bearings are also of exceptional size. All bearings are provided with screw adjustments, and can be got at without the slightest difficulty. The lubrication of all working parts is automatic and continuous: the cylinder is provided with a self-acting cup, and the crank-pin is fitted with a centrifugal oiler. This oiler and the cups at the top ends of the rods are supplied from a central oil box conveniently placed and provided with a sight-feed arrangement to each supply pipe. A splash guard, not shown in the illustration, is provided.

The engine illustrated is fitted with a throttle-valve governor on the Pickering principle, but an automatic expansion "shaft" governor—patented and manufactured by Messrs. Ransomes—is also used as shown in the larger engraving. The shaft governor acts direct upon the piston slide valve, and varies the cut-off in proportion to the load. The speed can be adjusted as desired while the engine is running with the Pickering governor, and a special attachment can be provided with the shaft governor to secure the same object. Messrs. Ransomes manufacture this engine in six standard sizes, and another series of engines with enlarged cylinders suitable for working at moderate boiler pressures.

The automatic expansion "shaft" governor acts directly upon the piston slide valve, and varies the cut-off in proportion to the load. The engine illustrated has a cylinder 8½ in. diameter by 8 in. stroke. It is coupled to a dynamo manufactured by Messrs. Laurence, Scott & Co., of Norwich. The electrical output is 180 amperes at 65 volts and 270 revolutions. The field magnets are constructed of magnet steel cast in one piece. The armature is built up in the usual way with charcoal iron disks, each of which is driven by three keys from the shaft. The conductors, of pure copper strip well insulated with mica, are let into slots milled in the disks.

THE ITALIAN NAVY.

LIKE England and France, Italy is still improving and augmenting her already fine navy, and among the latest additions to its effective strength is the cruiser Etruria, which has not long completed her trials. These were considered highly successful, as the engines developed a horse power above the contract and produced a speed of eighteen knots under natural and nearly twenty knots under forced draught. As will be seen by the sketch, the Etruria has a strong family likeness to a number of somewhat similar vessels built

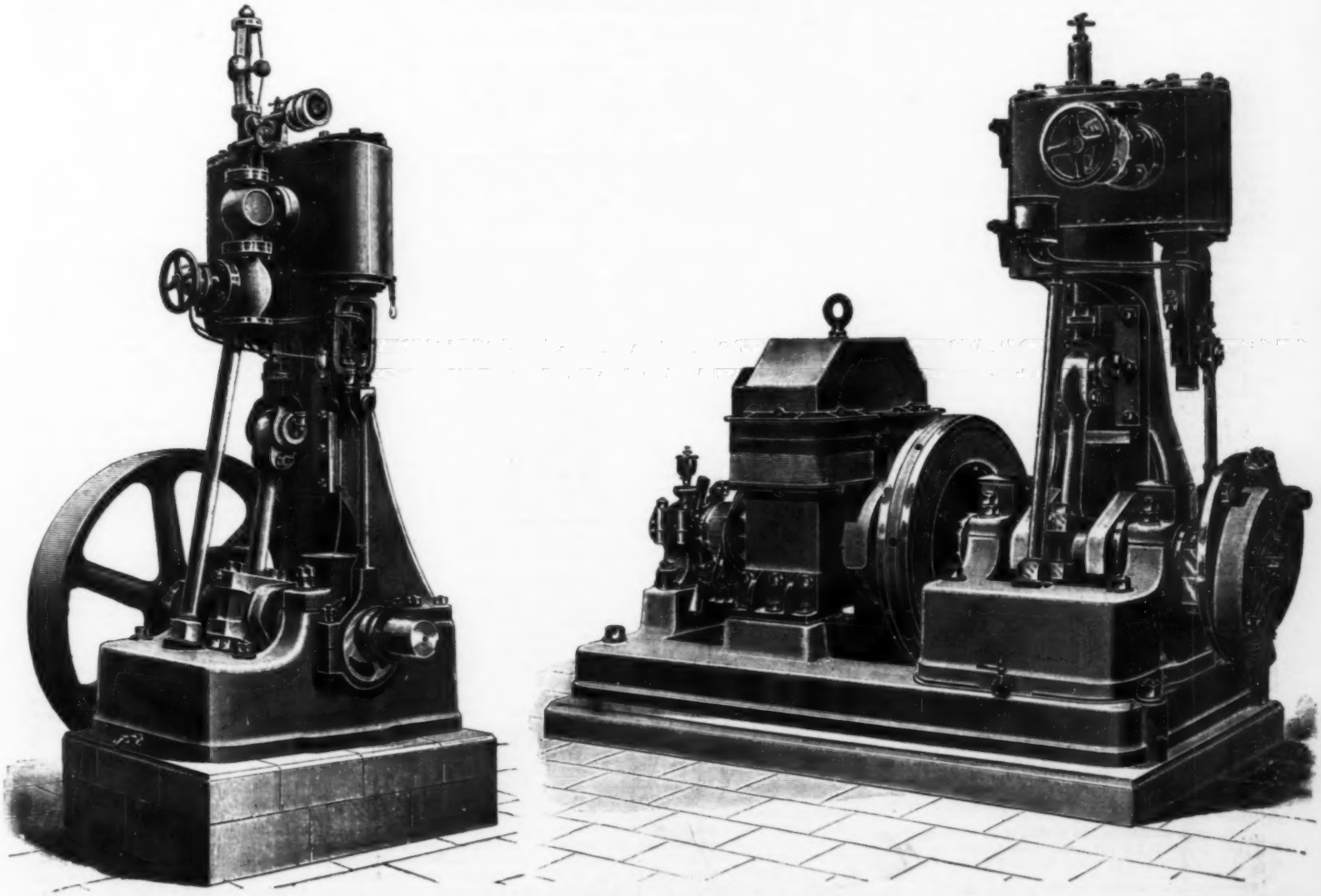


THE NEW ITALIAN WAR SHIP ETRURIA.

in this country to the order of various foreign powers. She was, however, built at Leghorn and constructed throughout of Italian steel. The Etruria has a displacement of 2,281 tons, is 263 feet long, with a beam of 39 ft. 6 in., and is protected by an armored deck. Her armament, which is very powerful for a craft of her tonnage, consists of four guns of approximately 6 in. caliber, six 4·7 guns, six 6-pounders, all quick-firing, ten machine guns, and two torpedo tubes.—London Daily Graphic.

THE AUTOMATIC STEERING COMPASS.

IN the new electric steering compass, invented by Lieutenant Bersier, of the French Navy, the needle of the compass actuates the rudder by means of an electric current, and thus precludes the possibility of any error on the part of a living steersman from fatigue or confusion. The difficulty of constructing such a com-



HIGH SPEED VERTICAL ENGINES.

pass hitherto has been owing partly to the heaving of the ship and partly to the difficulty of causing the delicate needle or card to act on the steering gear without impeding its motion. In Lord Kelvin's compass, for example, the card is merely a skeleton disk of paper, silk thread, and aluminum, with eight parallel wires of magnetized steel underneath, and it rests freely on a point or pivot of iridium or other hard metal by means of a cup of ruby or sapphire. The slightest contact with another body would disturb its motions in the magnetic field of the earth. M. Bersier gets rid of all contact by making the current from a Ruhmkorff coil spark from a metal point on the edge of the card to semicircular plates of metal insulated from each other and from the sides of the compass bowl in which they are fixed. The coil is excited by a battery if there is no electric lighting installation on the vessels; and a current of two to three amperes is sufficient. A wire from the coil leads to the pivot of the card and the cup over it, from which a light wire along the radius of the card corresponding to "North" conveys the current; and according as the ship is to the right or left of the course a spark three centimeters long passes to the right or left plate in the bowl and excites one or other of two electro-magnets forming the circuit of a small electro-motor of 150 watt power. This motor, turning to the left or right, works the steering motor like the hands of a man. The mechanism can be readily applied to any existing steering gear. The new compass has been tried in the French squadron for several months past, and is said to have succeeded perfectly well. The compass card seems quite indifferent to the spark, probably because the current of the coil is alternating and of low strength. Moreover, certain precautions are taken in producing the spark, and the coil and electro-magnets are at some distance, about five meters, from the compass. The new compass also registers all variations of course, if desired, the spark piercing a band of paper which is moved by clockwork up the bowl. Moreover, by a simple arrangement of Geissler tubes, steering orders can be automatically transmitted, and the course changed from any part of the ship. In practice the compass enables a course to be steered to a fraction of a degree, that is to say, with much greater precision than by hand, and it is claimed that it is specially suitable for passenger steamers, such as the Atlantic liners, as it would enable them to travel in a straighter line, thus saving both time and money. It also permits the vessel to be steered from the masthead compass.

THE EVOLUTION OF THE WORKSHOP.*

By C. JOHN HEXAMER.

IT may seem self-stultification to attempt the tracing of man's industrial progress in a single lecture. My apology is that a hasty review of the subject may stimulate thought and possibly lead some of you to take up a special department, which may ultimately be conducive of original research. Frequently, where minutiæ fail a broad generalization may be useful. The way in the forest is cleared by the ax, not by the razor. On visiting a strange town we first ascend an eminence, from which a general view of the topography may be obtained, thus gaining a clearer impression than by planlessly traversing the manifold ramifications of streets and by-ways. Even in literature the value of reading "in one sitting" has been advanced. The period of "drum and trumpet history" is passed. What we wish to know of a people is the economic conditions under which its members lived, labored and enjoyed themselves. Any light which you may shed on the history and progress of your own occupation is of great inherent interest and may prove valuable material on which others can build. Social and industrial customs are constantly undergoing infinitesimal changes, and, as the biologist discovers remnants of developments valuable in previous forms of life, but now useless and therefore disappearing, so the student of history, of sociology, or of economics, finds survivals and customs which have long outlived their spheres of usefulness. Why do we, when mourning, wear black and the Chinese white? Most persons would say that we wear such garments as a sign of respect to the deceased, but this was not originally the case. The custom is a survival of the time when such dress was worn to indicate the "uncleanness" which was popularly associated with death and the grave. The early Aryan Nature Worshipers in Greece armed their dead warriors with a sharp sword, as they believed they would need it in the other world. When this belief died out, the custom survived in a debased form, and a little gilded sham sword was placed with the dead.

Aristotle has called man "a social (political) animal." "A working animal" might be a more appropriate term, for without labor and the creation of values, true happiness and social intercourse are impossible. Man was originally a "jack of all trades," necessarily forced to supply all his own wants. With the rise of his social position and the development of organization in the race his activity became more intense and its field less extensive. In other words, the higher his social position, the greater became the subdivision of labor, and the more of a specialist did he become.

When and where man first appeared on earth is a much disputed problem. Where authorities disagree by hundreds of thousands of years, it is idle for the layman to speculate. I prefer to follow Dr. Daniel G. Brinton, the eminent Philadelphia anthropologist, who is not an extremist in his views. The earliest deposit where man's remains are found is that called the "drift," a series of gravel beds found in the valleys of the Thames, the Somme and the Manzanares. In these beds, stone tools and weapons have been discovered, lying in their original relative positions, with the bones of animals long since extinct, and which could not exist in those localities under our present climatic conditions. After the warm period in which these animals lived, one of extreme cold followed, which man, however, weathered. Huge glaciers covered Scotland, Scandinavia and Switzerland; the forests of France were the haunts of Arctic quadrupeds, such as the reindeer, the white fox, etc.

Dr. Brinton estimates the period thus consumed and the time requisite for primeval man to develop and to spread over the area in which he lived at not less than about 50,000 years; while other writers of eminence have demanded 200,000 years to explain all these changes in climate, organic life, denudation and deposition, etc.

The races of men have, largely on philological grounds, been subdivided into Aryan, Semitic and Turanian. The latter is the general receptacle into which are placed all those peoples of which we know little or nothing. The most ancient records of civilized man are probably those found in Chaldea. The most recent excavations of Layard, Loftus and Ernest de Sarzec, the French consul to Bagdad, show that other mighty and highly civilized cities existed in Chaldea before Babylon flourished. From these the culture of Babylon and Assyria, and in all probability that of Egypt, was derived. I will not venture to speculate as to the time requisite to bring this people up to the high state of culture in which, judging from archæological excavations, they must have been almost 4,000 years before our era. The earliest paleographic records we have are the mace heads and seals of Sargon, of Agade, dating 3800 B. C. The writing of this people, although yet distinctly linear, assumes the wedge shape, and the art of seal making seems to have been in advance of the sculptures of the time. These ancient Chaldeans were acquainted with most of the useful arts; they were metal workers, sculptors, weavers, etc. The art of music had been introduced, as is evident from representations of the harp, and of men with pipes and cymbals.

Although I should not like to go as far as those who boldly delare the Chaldaic origin of Egyptian civilization, if, in fact, I have a right to express any opinion on a subject in which I am not a specialist, I believe that the Egyptians, originally a hamitic people, were largely civilized by semitic immigrants, and that their culture and racial types were greatly altered by commingling with the semitic invaders. An authority on this subject has thus well summarized the present state of our knowledge on this subject: "For the present we must be content to say that in the remote period before the pyramid age, in the fifth millennium before our era, there was a sea communication between Chaldea, Punt, Egypt and Sinai, and an interchange of the elements of civilization. There is a convergence of the lines of origin of the two great civilizations of antiquity, but as yet their point of meeting is lost in the haze of the past."

It is, of course, exceedingly difficult to tell exactly what was the state of the people and of the workers of very ancient times. With caution, not driving analogies too far, we may learn something from the semi-barbaric tribes which we find in various states of progress at the present time. Fiske has well pointed out that the tribal forms of our American Indians have shed new light on the early tribal life of Greece and Rome. It is probable that the laborers of ancient Egypt were serfs, in condition not very different from the fellahs of the present day. Ebers relates how, when the statue of an ancient Egyptian overseer was brought to light, the native laborers at work immediately cried out: "It is our tax collector!" and it is probable the Jews who had settled in lower Egypt were not more severely oppressed than the rest of the people. They had settled during the reign of the Hyksos, semitic invaders who ruled Egypt for a time, and when, by a national revolt, native princes were called to reign, special favors formerly granted the Jews were revoked.

In Assyria and Babylonia there seems to have been a system of slavery and of castes.

Another semitic people, the Phœnicians, were the great artisans of antiquity. They built the temple for the Jews, and were akin to them in blood and in speech. From them the Greeks first acquired the arts, as is well shown by the ancient myths of Cecrops, Danaus, Cadmus, etc. Even the Greek religion, an Aryan nature worship, was largely influenced by them; thus Hercules was a transformed Melcarth, Aphrodite an Ashtoreth. Unfortunately, almost all records of the Phœnicians are lost, and all that we know of their great colony, Carthage, is what we have received from their implacable enemies, the Romans.

With the Greeks the ideal of beauty was born into the world. Their great maxim, "Nothing too much," guided them in everything and made them masters of absolute proportion in art, architecture and literature. Their daily life we know comparatively well. Most of their work was carried on by slaves. In conceiving of the condition of the slaves, we must, however, disembue our minds of the modern idea of slavery. These slaves were frequently highly cultured persons, who taught the children of their masters. Thus our word pedagogue is taken from pedagogos, originally an old slave employed to take children to school. Mahaffy tells us that the average price of a slave, calculated in our money, was $40, and that of a horse $60. The free Greek believed manual labor degrading, and the poor Athenian, rather than work, would serve on a jury and live on a few cents a day. Work was left to slaves and aliens. The ancient Greeks divided their property into two classes, the visible and the invisible. The great entrepreneur or speculator was honored, but bargaining was looked upon as a species of cheating, and was carried on almost exclusively by aliens. The rate of interest was 12 per cent.

Among the Romans we find a similar state of affairs, the work being left to slaves and freedmen (slaves set free). With them we find, for the first time, a sort of guilds; for the chapters which long were looked upon as a species of our secret societies seem to have been trade guilds. To Rome we owe the conceptions of law, order and civics. They gave us the contract, that great boon of the weak and poor, through which, by combining, they can compete, as incorporated bodies, with the rich and powerful. Rome committed moral suicide. One of the church fathers tells of a woman who danced on the grave of her twenty-sixth husband, she having been the sixteenth wife of the deceased. Ethical debasement was followed by physical weakness, and Rome died for want of men. When the Germanic tribes broke into Italy, they found it an empty egg shell readily crushed. We must be careful not to form our ideas of ancient life from plays and novels, except those written by eminent historical authorities, and these, en parenthese, are frequently not of high literary value. Thus, the people in Shakespeare's "Julius Cæsar" are not Romans and do not talk like Romans. They are the shoemakers, tailors, etc., of the time of Elizabeth, when Shakespeare wrote. This, of course, does not detract from the high standard of the play as a literary production.

It was destined that the Teutons should infuse new blood into decrepit Rome and ultimately hand down the ancient civilization in its present form. In order to readily collect taxes the government in later Rome bound the tillers to the soil, and we can understand the evolution of serfdom only by studying these conditions. These semi-serfs were protected by the army, which was largely made up of Germanic mercenaries. The usual Teutonic tribal form was: (1) A king, duke or leader; (2) the council of wise men or elders; and (3) the general assembly of the people, which last has survived, in one form or another, in the make-up of the executive and legislative bodies of to-day. When the Goths had conquered Rome, they formed the fighting or protecting class, and for this protection they exacted taxes and allegiance. From this system of allegiances feudalism slowly grew. After the Germanic tribes, the Angles, Saxons and Jutes, had conquered England, they brought with them their Teutonic usages, and when later they settled in towns we find the town council a feature which is still preserved in our New England town meeting. The chief was the reeve, and when representative government was installed, a reeve had to be chosen for the shire. He was called the "shire reeve," a term from which our word "sheriff" is derived. The shires of England, it should be explained, were at one time independent kingdoms. By the conquest of the Normans (a Scandinavian-Teutonic race which for a time had settled in Normandy) things were slightly changed, and a town or thorpe (the German dorf) assumed this form. There was the manor, with, first, the lord of the manor, usually a Norman, the village tract of cultivated ground around it; and the commons, composed of fallow lands and woods. In parts of Germany this is still found in the modified forms of the Gemeinde Wald and Gemeinde Wiese. Thus lived nine-tenths of the people in England. By the fifteenth century the serfs had become free in England. Serfdom lingered on much longer in Germany, giving rise to endless trouble, such as the terrible revolt of the peasants at Rothenburg on the Tauber.

After the restoration of order, and when the general shaking up caused by the migrations of the Teutonic races had subsided, and when walled cities had arisen to give protection to tradesmen and merchants, these classes united, for mutual protection, into guilds. These guilds in many cases became the real town governments, entering into agreements with the guilds of other cities and even with those of foreign countries. The emperors and kings, early recognizing in these guilds powerful allies against the haughty and unruly nobles of their realms, were anxious to extend to them their patronage. Thus were evolved the mighty leagues of the cities on the Rhine—the free cities and the Hanseatic League (with its own emporium in London at the steel yards) which could successfully cope with the most powerful princes of the time. Later the craft guilds originated, in which various workmen of a certain trade united, such as the weavers, fullers, armorers, cutlers, bakers, and crafts which are no longer practiced, such as the fletchers (makers of arrows) and bowyers (makers of bows). In London the guild of the goldsmiths became of great value to the world at large. They issued certificates on bullion deposited, and gave additional credit for such deposits, introducing thereby our present system of banking, known as the English system. The statement which is often made, that the bank of Amsterdam originated our system of banking, is erroneous. This bank issued certificates for the amount on deposit only. The guilds were true monopolies. They were beneficial, providing a common fund for the sick, for the aged, and for widows and orphans. They assisted members of their fraternity who fell behind in their contracts, and celebrated the annual feast of their patrons, for each craft had its own special patron saint. They regulated manufacture and prevented all competition, and were thus largely economic in their functions. Ben Akiba has well said, "there is nothing new under the sun," and many now make propaganda for a "new" theory, not essentially different from the one then in vogue. Everything moved in prescribed ruts. Every countryman was a member of a town community. Every merchant and mechanic was a member of a guild. In some cities art guilds were formed, such as the Meistersanger, who carried on poetry and music by absolute rule of thumb. Of all the prodigious quantity of so-called "poetry" produced under these conditions, but a few gems by Hans Sachs now retain value. The rest is rubbish.

But the mediæval system was to disappear and the ice-bound world of custom was to be broken up by the springtide of revivifying thought and learning. The period known as the rebirth (Renaissance) had come. Through the study of the methods of the ancients, of their mode of thinking, their philosophy, their literature and art, new literatures and new periods of art arose. The fall of the Greek empire, in 1453, drove many Greeks into Europe, and this also had some influence on the intellectual awakening, although by no means so decisive a one as is frequently ascribed to it in text books. The invention of gunpowder enabled the physically weak man to successfully cope with an armor-clad giant on horseback, and to destroy the walled castles of the knights. The art of printing rapidly spread the "new learning." The introduction of the compass opened a new era to navigation and exploration. Lastly, the fall of the mediæval church removed the shackles that had bound free thought. In the towns of Flanders, arts and manufactures flourished, and, under the greater security of free protected cities, gave rise to more liberal institutions and to greater freedom of speculation. The validity of the inscription on the peristyle of our World's Fair, "Ye shall know the truth, and the truth shall make you free," is borne out by history. With the increase of manufactures in Flanders, a reflex action was noticeable in England. The latter country had been a great grain producer, but with increased remuneration for its excellent wool, which was in great demand on the other side of the channel, an extension of sheep raising, and pari passu the inclosure of commons and the consolidation of small holdings, followed. When, through subsequent oppression, many liberal Hol-

* A lecture delivered before the Franklin Institute, December 8, 1893.—From the Journal.

landers emigrated to England, they introduced and taught the art of weaving and working woolen goods, creating a still greater demand for large sheep farms. The villagers and smaller farmers were got rid of by ignoring the old traditional security of tenure, by confiscating commons and by raising rents. Wherever tenants failed to perform all the conditions of their leases they were ejected, and expiring leases were not renewed. Violence and the bribing of legislative and judicial bodies were also brought into play, and were then much easier than now; for even the contemporaries of Henry VIII., when he wished to find a pretext for the judicial murder of Sir Thomas More, and therefore preferred charges of venality against him, were much surprised when the trial proved that the chief justice had never received presents from litigants, as was then a common custom.

In these various ways the small farms were depopulated. The ancient holdings and claims of the thorpes were denied, and the inhabitants of the villages were scattered to the winds by reason of the changes in the economic conditions. Those who had formerly been prosperous small farmers became laborers on large farms, others were retained as helpers on sheep farms, and only the more fortunate and intelligent became large farmers. But many found themselves members of a starving peasantry, vagabonds and sturdy beggars (although begging was by statute made a crime), and finally many became paupers and criminals in the towns. The former lords of manors became great landlords, of whom the large farmers rented their lands; and only farm laborers occupied the old villages.

In towns, the guilds were destined to be broken up. Whenever a number of persons are banded together to advance a monopoly, they are sure, fortunately for mankind, sooner or later to hang themselves in their own rope. The guilds had become very exclusive; allowing special privileges to the sons and sons-in-law of members, charging excessive entrance fees, and increasing the time of service and other requirements of apprenticeship, while the increase in the capital necessary for engaging in business made it more difficult for journeymen to become masters.

In the sixteenth century a class of capitalists, merchants, arose, known as "clothiers." These set spinners and weavers to work in the cottages of country villages, furnishing the raw material and paying a fee for the labor expended. This was the final death knell to the guilds, the remains of which exist in our own time only as narrow, aristocratic bodies. Carpenters' Hall, in our own city, is the historic remnant of a guild.

By the middle of the eighteenth century the towns had lost their supremacy in manufacturing. Cheaper living was to be had in the country, and weaving was carried on in combination with agriculture. But by 1750 a change in England had become imminent. The population of the country, which, at the time of Elizabeth, was only 5,000,000, had grown rapidly. Her colonies consumed large quantities of goods, and there was a demand for more rapid production, while capital had accumulated, and was anxiously awaiting the opportunity for investment. In 1761, the English Society of Arts offered two prizes of fifty and twenty-five pounds respectively, for the best and the second best invention for spinning six threads by one person; but the devices submitted were not practical.

The era of invention was, however, soon to dawn upon the world. In 1764, Hargreaves invented the "spinning jenny," by which first eight, then twelve, then twenty, and ultimately a hundred threads were spun at a time. The secrecy in which this invention was at first shrouded was soon divulged, and in less than a dozen years the jenny was in general use. In 1768, Arkwright gave to the world the "water frame." Crompton invented "the mule" in 1776, combining the advantages of the jenny and the water frame. Rapid improvements in carding machinery followed. Cartwright's "power loom" was invented in 1784 and improved in 1787, and was universally in use by 1800. In 1792 our great American inventor, Josiah Whitney, gave to the world the cotton gin. There was now a pressing need for greater and more reliable power to drive machinery. Watt improved the steam engine in 1769; and in 1785, one of the most important dates in history, the steam engine was first used to furnish power to a cotton mill. This broke up the system then in use. Special factory buildings of greater size had to be constructed, and these were now located near fuel supplies, and where raw materials and products could be more readily handled; the details of manufacture became more complex, greater capital was requisite for a manufacturing enterprise, and its management necessitated greater executive and business ability. The prices of goods were rapidly lowered by the enormous increase in production, but the introduction of more advantageous methods of manufacture nevertheless permitted the rapid accumulation of great fortunes. The great entrepreneurs became a new aristocracy, that of money.

There was now a seething wave of humanity, from the country to the towns, the reflex of that which had once set in from the towns to the country. Forced by additional inclosure acts, the poorer country population swarmed to the factory towns, and England became, as has been well said, "a great industrial organization, where everything was done on a large scale, and the world was her market." In this great workshop, the laboring population, having lost its hold on land, on capital, and on the direction of the enterprise, was cut adrift. The great masses of the population were mill hands, and practically the slaves of employers. There were then no associations and trade unions, and deplorable conditions existed. Wages were low and hours extremely long, women and children were worked beyond physical endurance, and their habitations were those of squalid misery. I will not dilate on the sickening details of physical and moral debasement of "the sweating systems" of those times, when children, in order that manufacturers might procure still cheaper labor, were apprenticed from almshouses.

The world was then laboring under a most inhuman economic system. The "laissez faire" doctrine was carried into practice, with its appendages, the theories of the "wage fund" and of the "iron law of wages," teaching that there is in each country a certain amount of money to pay wages, and that if the population increases, there must be a corresponding decrease in wages until a sufficient number perish to restore wages to a living standard for the remainder.

As is so frequently the case, help was not to come from educated theorists, but from the sound common sense of the middle classes. Amid the tremendous opposition of manufacturers and of disinterested political economists and their followers, who declared that the government had no right to interfere, the first factory act was passed in 1802. Its interference was exceedingly mild, its enactments being limited to such trivial requirements as those providing for the ventilation and whitewashing of factories, stipulating two suits of clothes annually for "bound children," and limiting the working day of these unfortunates to twelve hours. Again, the exertions of the sound minded middle classes secured, in 1833, the appointment of a parliamentary commission, whose report was followed by an act which stipulated that no children under nine years should be employed; that those between nine and thirteen years of age should not be worked more than eight hours, and those between thirteen and eighteen not more than eleven hours each day, and that boys under twenty-one and women should not be put on night work.

Slowly the era of trade unions and socialism came into being. Laborers began to recognize their community of interest, and attempted to unite, but an act of 1799 made it a crime for them to combine for an increase of wages, or a decrease of working hours, or to persuade others to leave work; and it was not until 1875, after a number of previous ameliorating acts had been passed, that the last remnant of illegality was removed from such combinations. It is unnecessary for me to dwell on the phases of the struggle in our own country, the several State acts, labor commissions, etc. At present Australia, to which we owe so many reforms, is attempting to evolve a practical system of arbitration. The weapons wherewith capital and labor have been combating are the "strike" and the "boycott" on the one side, the "black list" and the "lockout" on the other. These, however, are too well known to require detailed description here. It is noticeable that both sides are becoming more moderate in their views, and that their disputes are becoming less acrimonious. Labor unions act like double-edged swords. Restricting, as they do, individual freedom of action, their members must necessarily sacrifice some of their personal freedom. But human social progress has been in the same direction. As citizens of a State and of a community, each of us gives up certain individual rights for the general welfare. We are slowly recognizing the equity of State interference, notwithstanding the trumpet blasts of such ingenious theorists as Herbert Spencer.

Brushing aside feudal aristocracy, which is practically effete, though still lingering on in parts of Europe and in the adoration of American heiresses, we may, for practical purposes, divide humanity into three classes: the capitalist or money lender, who receives interest; those who build and operate mills, keep stores, manage, receive profits, etc.; and those who do daily work and receive wages. It has been attempted to unite these functions by a system of co operation, as in the experiment of the Rochdale pioneers in 1844, when twenty eight workmen each subscribed $5, agreeing to buy only at the co-operative store. In 1882 there were 1,268 such stores with 650,000 members, and it is stated, on reliable authority, that in northwestern England one-fourth of the population buys its supplies from co-operative stores.

Another experiment was that of the Minneapolis coopers. In 1874 sixteen of those coopers contributed $15 each, and established a shop of their own, dividing the profits. Leclaire, a Paris painter, in 1842 began the system of sharing profits with employes who had been long in his employ. The Oxford Building Association was an attempt to stimulate thrift, and extended its example, in 1831, to the United States, and the plan has proved astonishingly successful in our city of homes. Great competition has also called into being combinations of manufacturers known as "trusts."

In recapitulating these successive steps of combinations, accompanied by limitations of the personal rights of individuals, we cannot forbear asking the question, Are we drifting toward socialism? This is a proposal to abolish competition and individualism, substituting for them some form of government or social control over land, capital, management, distribution and labor. It opposes competition, rent for land, interest on capital, computed profits and the individualistic ideal of society. In other words, each individual works for the community instead of for himself, and each one receives from the community and not from other individuals or corporations. Wherever the system has been tried practically it has proved a failure. In early colonial times in this country, we find it wrought starvation. In Russia the great famines are the direct outcome of the communistic system of the Mir.

Louis Blanc is the originator of that form of modern socialism which is opposed to the radical measures formerly advocated, and proposes the utilization of present governments to commence reforms, and thus gradually to lead to socialism. (Another form emanating from the brains of poets and visionaries has given rise to what is known as nationalism.)

It would be idle to speculate on what we shall ultimately reach, but I think it is safe to say that we are tending toward government ownership of railroads, the telegraph and telephone lines and all municipal necessities. In Germany, a great statesman, Bismarck, has introduced compulsory insurance.

After tracing thus rapidly human industrial progress from the most ancient times to the present, we cannot more aptly close than by asking and attempting to answer the question: What is the present status of the evolution of the workshop? Competition has broken down in many lines of practical business, and trust combinations of all sorts flourish, notwithstanding the opposition of statutes, courts and public opinion. Even violent measures, such as reductions of tariff, free trade, etc., prove of no avail, as powerful trusts are better able to successfully meet foreign competition than small business concerns fighting single-handed. The raison d'etre of trades unions is now generally recognized, and they are encouraged. Co-operative efforts have been in part successful and are still on trial; and factory laws have been enacted in all civilized countries.

We have no reason to fear the future. Extremists may prove temporarily obnoxious, but will not prevail in the end. They may, indeed, do good, as the happy mean is found between the extreme pendulum swings of human thought. These problems will be solved, as all human progress has been accomplished, by infinitesimal changes directed by economic conditions. Nor need we dread the increase of population, for history and sound economics clearly teach us that such fear is groundless, and have established the grand ethical axiom, that bed-rock of human experience on which we can safely build, that in the end right and truth will prevail.

AN APPROXIMATE METHOD FOR DIVIDING ANGLES OR ARCS.

By MAX LOWENTHAL, School of Mines, Columbia College.

As it is often required to divide an angle or its subtended arc into a desired number of equal parts, many attempts have been made to discover a mathematically correct and, at the same time, convenient method for accomplishing this end. It is now an established fact that certain subdivisions can only be obtained by the construction and employment of higher curves, as the hyperbola (F. R. Honey, Ph. B. Yale Univ., SCIENTIFIC AMERICAN Jan. 31, 1891), or the conchoid (Wentworth, Analytic Geometry, Art. 199) and others. Although these methods are correct, a practical machinist or draughtsman would not be in a position to employ them, and for them, and others, who desire to divide angles or arcs rapidly, thereby sacrificing complete accuracy, the following method is proposed.

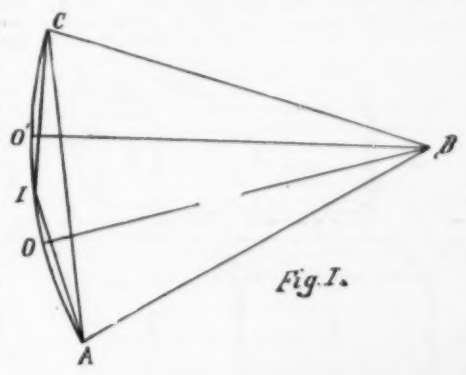


Fig. I.

Let it be desired, for example, to trisect the angle A B C, Fig. I. Draw any line, D E, Fig. II., of considerable length, say nine inches (this being a multiple of three). Erect at E a perpendicular, E F, equal to the chord, A C. At G, the middle point of D E, erect a perpendicular G H equal to the chord, A I; A I being equal to I C. Then join H with D and F by straight lines. Divide D E into three equal parts, D K, K L, and L E. Then the perpendicular distances K M and L N will be equal, respectively, very nearly, to the chords of one-third and two-thirds of the arc, A C. Lay off K M three times on the arc, using this distance as a chord; then draw O B and O' B.

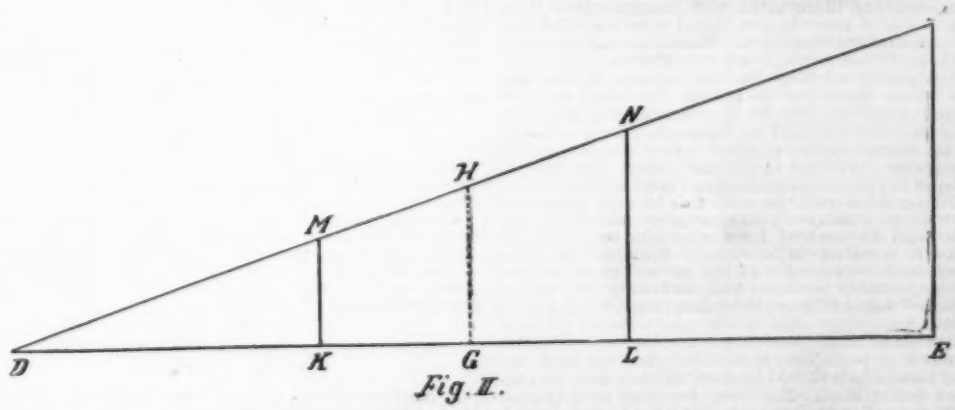


Fig. II.

Should it be required, for example, to divide the angle into seven parts, make the length of D E a multiple of seven, say fourteen inches, and proceed as stated above, letting the distance D K be one-seventh of D E.

A SIMPLE ENLARGING PROCESS.

HERR C. M. GRUBY, of Vienna, contributed the following article to Der Amateur Photograph, and has sent it to us with some diagrams, which we reproduce.

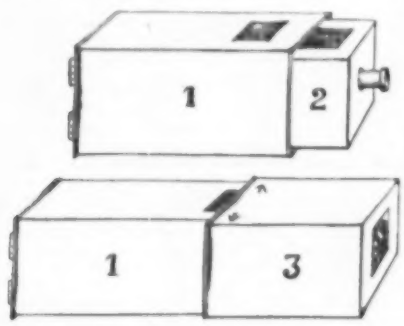
As is well known, most exposures, especially on long excursions, are made with a hand camera, and, on account of the convenience and portability, these do not run above the quarter plate. The results, be they ever so exact and satisfactory, suffer from their smallness, and especially is this the case with instantaneous pictures, which often include a large number of moving objects. Who has not wished, over and over again, to be able to enlarge this size in a simple and convenient way? The ordinary processes are either too costly—especially if an apparatus for artificial light be used—for they often cost more than the camera itself, or they are inconvenient when adapted for daylight enlarging, since a window has to be fitted with a reflector for obtaining equal illumination, and an absolutely parallel easel or support must be used, which everybody does not possess.

For the last year I have used a very simple apparatus which has proved very efficient and which every one can construct or can have made for about two shillings. It enables any negative to be enlarged quickly and accurately to 10 by 8 or larger, and with it the whole work is finished in about two minutes, and printing in the ordinary printing frame, which is so much influenced by the weather, is avoided.

Three boxes are made of ordinary deal, of about ⅛ inch thickness. No. 1 is 24 inches long and 10 by 8 inside. This is open at one end; at the other is screwed a box printing frame, and the joints are made light tight. No. 2 is 3 inches long, and is just small enough to slide into the open end of No. 1, and made to fit closely. It is open at the end toward the printing frame, and the other end is closed by a board, to which the lens is fastened. The lens board, No. 2, is made like a box in order that it may slide absolutely parallel to the negative and the printing frame. The outside is left plain. No. 3 is 16 inches long and sufficiently large to slide over No. 1, and is closed at one end with a board with an aperture for the negative, which is held by two turnbuckles.

This is the complete apparatus, which is painted dead black inside.

A ¼ plate lens is now fastened in position; either that with which the negative was made, or, better still, a rapid rectilinear with large stops, and the box is placed with open end in No. 1. Then a negative is fastened in the opening of the third box, and this



is placed over No. 1. The negative is placed with the film side turned inward, and no ground glass is used, for it is useless with this apparatus. Care is taken that everything slides accurately and easily.

The negative is now directed toward the light, and focusing is effected on the plate glass of the printing frame, which should be covered with matt varnish, or, better still, on a ground glass, which should be made exactly to register. One begins with half plate and gradually moves the lens and negative boxes to 10 by 8, and for portraits and objects in the middle of the negative to still larger sizes, and marks on the outside of the boxes accurately the position of each size. The focus is kept by a couple of pins or screws at the side. For greater convenience a hole 6 by 4 inches can be cut in one side of No. 1 box, so as to be able through this to shift the lens, and after focusing cover this opening with a card.

For enlarging, the lens is stopped down, the room darkened and illuminated with orange yellow light. The bromide paper is now placed sensitive side to the front in the printing frame, behind lies a stout black card, and then fasten down the pressure back. Over the negative a folded focusing cloth is thrown and the whole apparatus taken out, the negative is directed to the sky, the focusing cloth taken away and an exposure of from 10 to 30 seconds given, according to the negative; the negative is then covered up and the paper developed in the dark room with the developer the phographer considers most suitable.

One great advantage with this process is the ease with which a thin foreground or other part of the negative can be covered for a second or two with the hand or focusing cloth, without touching the other parts, and the omission of the ground glass in front of the negative produces such brilliancy that the uninitiated would suppose the enlargement to be a direct print.

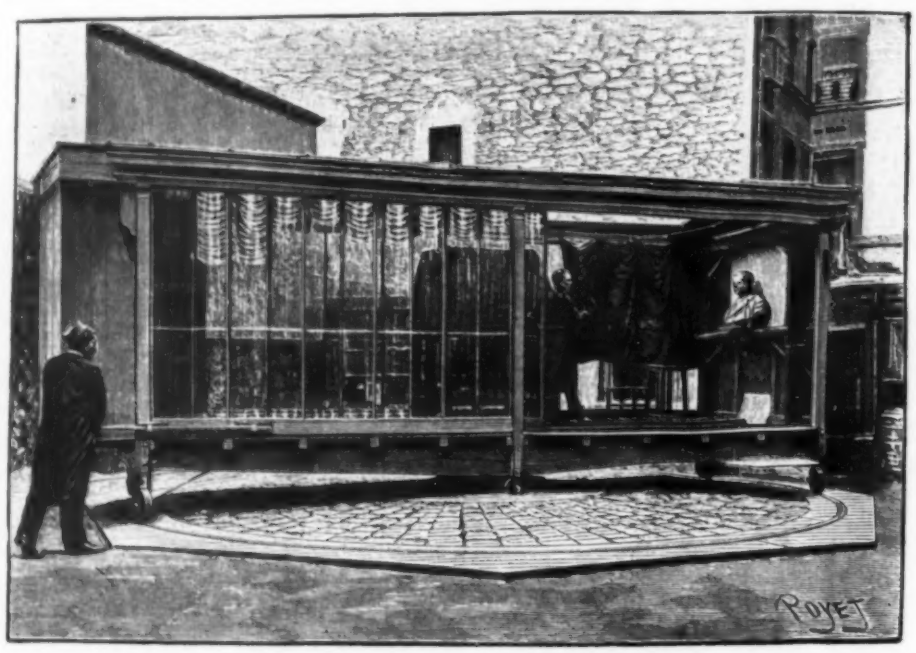
I presume that most amateurs know how to use bromide paper. The rapid kinds are the best, and only those kinds should be used which will lie flat, not the rolled up kind. Most manufacturers pack the bromide paper flat in sizes up to 10 by 8. If glazed prints are preferred, the enamel bromide papers which have been lately introduced can be used, and they give results very similar to chloride prints. Obviously smaller sizes than ¼ plate can be used. One can also make proof enlargements from a wet negative; for this it is only necessary to lay a piece of card, with a small opening, over which is placed a small piece of bromide paper in the printing frame. The apparatus can be held during the exposure in the hand, for as it consists of immovable parts, movement does not hurt.

Certainly every amateur who has once tried this simple and certain enlarging process will enlarge every negative without exception—naturally assuming that the negative is suitable for the purpose—as the whole operation can be done, not only in about two minutes without any great preparations, but also because equal results can be obtained. The general introduction of this simple apparatus in every amateur's workshop would not only make the large camera unnecessary, but also replace the old photographic tone by the beautiful bromide enlargements with tones like platinotypes and steel engravings.—The Photogram.

REVOLVING PHOTOGRAPHIC STUDIO.

FOR photography, as well as for painting, one always seeks a studio having a northern exposure in order that he may not be inconvenienced by the sun. Still there are cases in which it would be preferable to have another exposure, especially on a day in which the sun does not show itself, but remains hidden behind a stratum of clouds. It is then desirable to take advantage of every bit of the little light that it gives. And even on certain days in which the stratum of clouds is not very thick and transparent, we have a very soft filtered light that would permit of taking instantaneous photographs were the studio well placed. This might prove valuable for photographing infants, or even adults, whom it is necessary to make assume a pose that it is difficult to maintain. When it is a question of the reproduction of drawings, pictures, etc., one is often inconvenienced, too, when he is obliged to limit himself to a definite position of the photographic apparatus.

If it is possible to await a favorable light, the inconvenience is not very great, but in an industrial establishment which has to turn out much work and in all kinds of weather, one is obliged to have recourse to expedients that are not always easy to put in practice, or to an intense artificial light that is often difficult to procure. In order to surmount such inconveniences it would be necessary to have a movable studio that shifted with the sun; and many professionals have probably thought of this without dreaming of the possibility of putting the project in execution. The problem has been solved under the most satisfactory conditions by one of our skillful operators, and we propose to make his installation known.



REVOLVING PHOTOGRAPHIC STUDIO

In order to obtain all the advantage possible from the light of day, this operator, who is one of our best known heliographers, Mr. Dujardin, has recourse to an interesting arrangement which is illustrated herewith. It will be seen that his studio consists of a large glazed car mounted upon wheels. A circular rail upon which the latter rest permits of causing the system to turn in all directions with ease. It is thus possible to obtain the position that is most favorable for the pose of the object or person to be photographed.

The model once in place, there is nothing more to be done but to try to obtain the most advantageous illumination by changing the orientation of the studio. This is undoubtedly more convenient than the always somewhat difficult manipulation of curtains, the use of which, moreover, is not here excluded.

An installation of this kind is perhaps not within the reach of everybody, but it may, nevertheless, find an application among those who have the necessary space at their disposal, and it merits being made known to them as an arrangement capable of rendering them genuine services.—La Nature.

THE DEVELOPMENT OF GELATINE ARISTO PRINTS.

IT has been known for some time that it is practicable to produce excellent gelatine aristo prints by development in a much shorter time than is required by the print-out method commonly used.

Probably for lack of workable formulæ, this useful modification in practice has not yet received much attention from American workers. This obstacle, however, is now removed by the practical method introduced before an English society by Mr. W. J. Wilson, which we give herewith.

There are many occasions in the daily practice of our larger studios, such as when large numbers of pictures are required for illustrative or commercial purposes, where a speedy process for producing photographic prints would be a boon to the busy worker harassed by dull weather, etc. By such a method, also, promptness in filling orders may be assured, with other obvious advantages.

Mr. Wilson asserts that any gelatine print-out paper is suited to the process given. He advises that, to secure pure high lights, all white light be excluded from the paper previous to its insertion in the printing frame, and abundance of yellow light be used in its manipulation before exposure.

The amount of exposure to be given to the paper under the negative is left to the discretion of the printer, so long as at least a faint impression of the image is secured. With some negatives only a few seconds will be necessary; with others, an exposure of five or ten minutes will be required. The fainter the image, the longer the development.

A visible image having been secured, the print is immersed for from two minutes to eight minutes in a ten per cent. solution of potassium bromide. If the print is left too long in this solution, or if the solution is too strong, the gelatine film will soften and after-manipulation will be difficult. In this bath the whole of the silver is converted into bromide. Care should be exercised to avoid the formation of bubbles upon the surface of the paper. To avoid these, place the print face downward in the bath until completely immersed, then drain it once or twice over the edge of the dish, afterward reimmersing it in the solution. The print is afterward washed for a minute or two in water.

The developer recommended is:

Hydroquinone	3 grains.
Sulphite of soda	4½ "
Bromide of potassium	6½ "
Carbonate of ammonium	6 "
Caustic soda	1½ "

per ounce of developer. All these except one are indispensable, and that one is the carbonate of ammonium. As to the actions of these various constituents, there is still a good deal to learn of all of them, but so far as I know they are as follows: The carbonate of ammonium is a powerful restrainer, it keeps the developer clean, and it has not exactly the same action as the bromide; moreover, for reasons to be afterward stated, you cannot use more than a certain limited quantity of bromide; but as you can use carbonate of ammonium in addition, and in that way increase the restraining action, I prefer to retain it, although it is not a very nice kind of material to use, and is liable to deteriorate. The bromide has its usual action of keeping the developer clean. As regards the quantity to be used, it really does not seem to matter whether you take two grains or ten per ounce of developer; but if the proportion is increased beyond about that amount, it will depend upon the proportions of hydroquinone and sulphite whether you can go on. If there is very little hydroquinone and sulphite in the developer, and you increase the bromide, coarse prints will be produced; if you use a large excess, it eats away the fine details, and, in fact, will destroy the image altogether.

I do not know that there is any advantage in long development, and I am inclined to think short development gives cleaner results: it is a matter of convenience. If a professional photographer is dealing with a good many prints, and is using a rapid developer, he has not time to look after them, and some may be spoilt by over-development. The hydroquinone and sulphite have both an action on the gradation of the prints, and there is a large control over the result as regards gradation.

As in the operation of bromizing, so in development, the formation of air bubbles should be avoided. Another point is that the prints should be well covered with the solution during development, and the air should not be allowed to get at the paper.

As soon as the print is judged to be sufficiently developed it should be stopped instantly, which can be done most effectually by plunging it into a weak solution of citric acid. After washing for a quarter of an hour it will be ready for toning, for which the sulphocyanide bath is recommended.

By this method soft prints may be secured from hard or dense negatives, or vigorous prints from thin and flat negatives. We shall be pleased to hear of the results obtained by our readers in using this method with American gelatine papers. At an early date we hope,

personally, to give the matter a careful trial, and will communicate the results along with such further information as we may receive.—Wilson's Photo. Mag.

[THE BUILDING NEWS.]

METHODS OF CONSTRUCTING CHIMNEY FLUES AND PIPES AT PARIS.

THE use of earthenware pipes for the building up of chimney flues is now universal at Paris and in the larger French towns. Rarely, except in the case of party walls or in the case of small houses, are the flues built of brickwork. The pipes are considered to permit much more rapid work, the flues are clean and thoroughly sound, and pargetting is unnecessary. Again, in the case of a flaw it is generally an easy matter to replace the broken portion of piping. The chimney breast is not employed, and there is, therefore, no necessity for foundations for the latter.

There are a number of different systems of piping, each one claiming perfection and having its partisans. It will, therefore, be interesting to remark a few of those most generally employed at Paris, as shown in Figs. 1, 5, 10, and 11.

All of these are roughly fluted on the two outer surfaces, in order to firmly hold the proper thickness of plastering. The interiors are purposly left rough, to afford a proper hold for the soot, and in the case of the rectangular pipes the corners are slightly rounded.

Some years ago it was the custom generally at Paris, on the construction of a new building, to form the necessary flues in the thickness of the party wall, the first owner of the wall building at the same time as his own flues a similar number of flues for the use of the building which would eventually be built against the party wall. This manner of building flues in the thickness of the party wall was soon, however, forbidden by the building regulations; but after a certain time the prohibition was withdrawn, and it was left to the party owners to construct the joint wall as they might agree upon. The insurance companies, however, then decided that they would take no responsibilities for houses of which the party wall was thus built, for it was evident that a wall pierced in a large portion with chimney flues was not sufficient protection against fire, and did not form a sufficient division between two properties.

This being the case, although the construction of flues in party walls is not forbidden, and is in some cases found necessary, it is now the custom to build the chimney flues against the surface of the wall by means of the hanging pipes shown in Figs. 12, 13 and 14.

The "wagons," or pipes for building into walls, are made of dimensions suitable for walls of the thickness of one brick to two and a half bricks. The walls of the Paris houses are generally built of a thickness to allow a 14 in. by 9 in. flue; in the case of other walls the hanging pipes are generally employed.

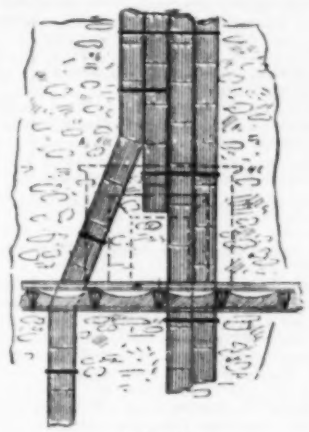


FIG. 14.

Fig. 1 is a system of pipe made by the Vaugirard Brick Co., and presents many advantages over some of the other systems. The flue is rectangular, with rounded angles, the exterior is provided with projections the size and shape of an ordinary brick. These projections are so arranged as to allow one pipe to fit against the other, as shown in Fig. 2. The joints, as will be seen by Fig. 3, representing the grouping of three inclined flues, are broken horizontally and vertically. These pipes in all systems are made for inclination at various angles; the angle may not, however, be more than 30° from the vertical. The system as shown in Fig. 3 has many merits; the putting together is very simple, the pipes are well bedded together; the joints being well broken, there is little danger of leakage. Again, the rectangular projections allow proper bonding with the brickwork of the wall. In the case that any of the iron joists of the floor require support on the portion of the wall pierced by the chimney flue, by employing two inclined pipes, Fig. 4, sufficient room is obtained for the passing of the joists, and a firm bedding is obtained on the projecting edge.

Another system (Fig. 5) is the "wagon solidaire Lacote," having a height equal to four bricks. The ends are alternately convex and concave, the pipes are fitted together as shown in Fig. 6, where two flues, one inclined and one vertical, pass up from the floor below, and two others inclined, supported by a bar, take the smoke from the two chimneys on either side of the wall. This system is much employed, but an inconvenience is that of joining the rounded end of the pipe with the square brickwork of the wall.

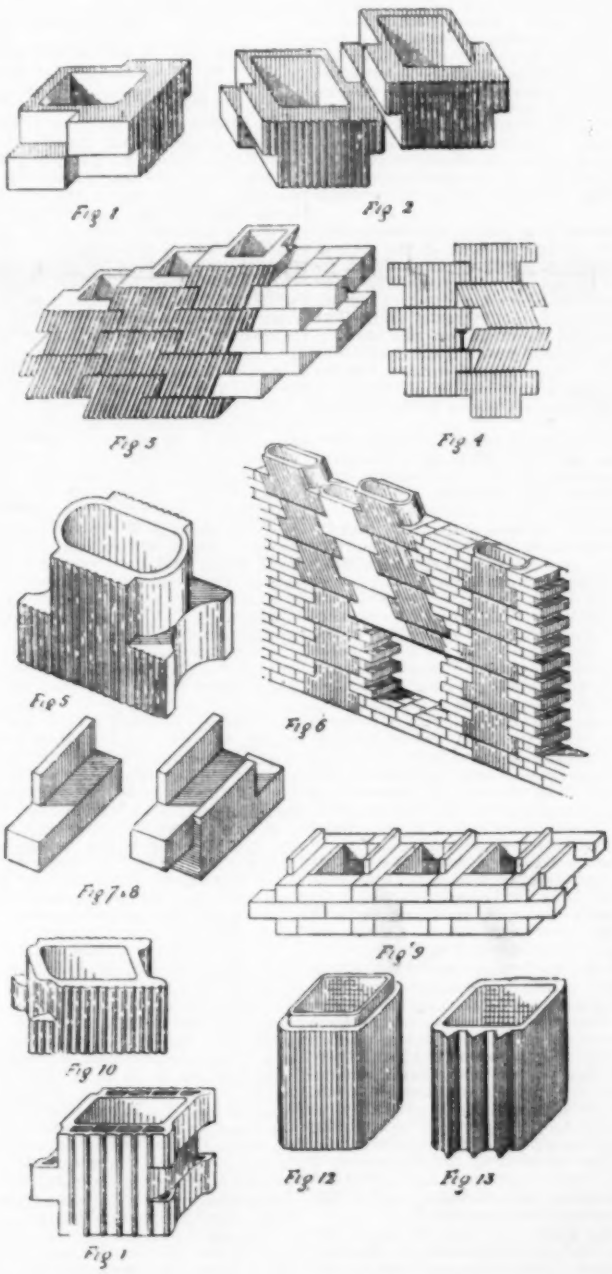
Another system is that of Fig. 10. The objection that the projecting ties are weak disappears when the pipes are placed together and well jointed.

Fig. 11 shows the system Duprat, of the height of three bricks. The outer walls are hollow, and are supposed to afford greater protection and solidity. In these last two examples the horizontal joints are not broken.

The system of chimney bricks Lacote is also much employed. This brick (shown in Fig. 7) is of the height of two bricks, the upper vertical projection forming the thickness of a brick. The length of this brick is of the thickness of the wall, less one half brick. When two are fitted together, as in Fig. 8, they form the thickness of the wall, the extremity of each resting on the wall, the remaining portion on the lower one. This special brick forms a secure joint, and has the advantage of making a neat jointing in cases where the wall is left unplastered.

Hanging pipes, or pipes fixed to the wall, are much employed, and are most useful and convenient, either in the case when the available portion of the wall is already filled with flues or in the case of thin partition walls, or, if necessity is found, to add one or two flues to those already existing. The regulations allow these pipes to be fixed to walls of not less than one brick thick; for the topmost story, however, they may be fixed against partitions of a $\frac{1}{2}$ in. thickness. The ordinary form known as the "Boisseau Gourlier" is that of Fig. 12, of the height of six bricks, with rough surface for plastering and ribbed end. That of Fig. 13 is known as the "Lacote," and has on the side toward the inside of the wall three angular projections, called witnesses, intended to oblige the plasterer to cover with the regulation thickness of plaster. This regulation thickness is a little over 3 in., including the thickness of the pipe. These pipes are fixed against the wall with plaster as in Fig. 14, showing three flues from the lower floors, and one to take the smoke from the chimney of that floor.

The pipes are further firmly fixed to the wall by means of iron straps, placed about every 5 ft., and the whole is properly covered with the regulation thickness of plaster. These pipes are most convenient, for they can be inclined in any direction to avoid doors or windows; they are very light and economize space. Most of these systems are patented in France and abroad, and form a source of large profits to brickmakers. The wall pipes cost from £3 to £4 10s. per hundred, and the hanging pipes from £2 to £3 10s. per hundred, less trade discount. There is, therefore, a great economy in employing them, both as regards cost and labor.—Arthur Vye Parminter.



THE NEW GAS.

FOLLOWING up his letter to the London Times, Professor Dewar writes further: I have pointed out certain difficulties which suggest themselves as to the elementary character of the new constituent of the atmosphere, and its presence in normal air to anything like the amount of one per cent. If, however, we assume the substance separated by Lord Rayleigh and Professor Ramsay to be composed of known elements, then the experimental results can be easily explained. We have only to assume that when nitrogen enters into chemical combination with another substance, whether oxygen, as in the case of Lord Rayleigh's plan of working, or magnesium, as in that of Professor Ramsay, a small portion of the gas is condensed molecularly into an allotropic form, having one and a half times its normal density. We are familiar with such action in the case of the transition of oxygen into ozone, and practically identical methods are being employed in the assumed separation of the new substance from air. It would appear that electrical discharges acting alone upon nitrogen do not condense it, and in this respect it differs from oxygen. Yet it is well known that electrical stimulation of nitrogen does produce two distinct spectra, presumably due to different molecular conditions.

The theoretical density of the new nitrogen compared to hydrogen should be 21, while the experimental numbers are between 19 and 20, though these are admittedly too low. Such a body chemists would infer ought to be characterized by great inertness, because phosphorus, the element most nearly allied to nitrogen, easily passes into an allotropic form known as red phosphorus, which is relatively to the yellow phosphorus an inert body. If therefore such an active substance as phosphorus becomes in its condensed form far less active chemically, then by analogy nitrogen, so inert to start with, must in its new form become exceedingly inactive. No doubt the passage of the ordinary nitrogen, or the diatomic form of the substance, to the triatomic form of the same takes place with evolution of heat, just as in the similar transition in the case of phosphorus. While this hypothesis accords with the facts, it does not necessarily support the view that the triatomic nitrogen is present to the extent of one half per cent. in normal air On the contrary, the inference is that the new substance is being manufactured by the respective experimenters, and not separated, as they imagine, from the ordinary air. If the suggested view is correct, it is certain that the allotropic nitrogen would be far less volatile than the ordinary variety, just as the vapor pressure of red phosphorus is small as compared with that of the yellow, and therefore it ought to be separated from liquid air by its higher boiling point, even if it did not become solid at the existing temperature. Its non-appearance supports the view that it can be present in air, if present at all, only in exceedingly small amount. Yet were it produced in ever such small quantity—for example, by the passage of electric discharges—its very inertness would favor its accumulation, just as the high chemi-

cal activity of ozone tends to its dissipation. If, therefore, in the long course of ages the quantity of this triatomic form of nitrogen remains inappreciable, we are scarcely entitled to assume its existence as a normal constituent of the atmosphere, unless we also assume that it is being utilized in some unknown way.

It is not the first time that chemists and physicists have been tempted to believe in the production of an allotropic form of nitrogen, and to accept it as explaining certain curious phenomena, but hitherto the assumption has always broken down on more careful investigation. This time we may be permitted to hope that the elusive allotropic form has been fairly captured.

ON THE CHEMISTRY OF COAL FORMATION.*

By J. W. THOMAS, F.C.S., F.I.C.

WITH a view to lead up to the consideration of the "proximate chemical constituents of the various kinds of coal," a short sketch of the chemistry of coal formation will open the question respecting further experiments to increase our knowledge of the subject.

It is to be expected that the age of the coal, and the physical conditions such as the effect of water, heat, and pressure, should throw considerable light upon the chemistry of coal formation. If the tertiary lignites of Bovey Tracey are placed in position above the upper bituminous coals of the South Wales field, a striking gradation and regularity of change is seen between the lignite and the anthracite, as shown in the accompanying table. The lignites are soft, anthracite is very hard; lignites are wet, anthracite dry; lighites show high hygroscopicity, anthracite low. In the table the physical characters run fairly parallel with the chemical. In East Yorkshire the oolitic coals—jet, for instance—are as hard, and dry, and as little hygroscopic, as anthracite; and so is the highly bituminous Wigan cannel. The Scotch coals also furnish exceptions to the rule, and the physical conditions of the coals of Great Britain are of little value in determining their chemical character; and as there are instances of bituminous coals lying below more anthracite varieties, even the depth of the coal below the surface is no safe criterion of its chemical composition.

The decomposition of peat and wood to-day teaches us more respecting the chemistry of coal formation. The late Dr. Angus Smith showed that the woody fiber of recent decaying moss decomposed much quicker than the resinous and gummy portions, the result being a considerable increase of resinous matter in the older peat, and a corresponding loss of combined oxygen.

Observing the decomposition of wood to-day in the case of larch and pine railway sleepers, we see that the portions where the resinoids are in least quantity are first attacked, the knots and other parts saturated with resin and terpenes being preserved after all the woody fiber has disappeared. We know, too, that decomposition is greatly accelerated by myriads of insect and lower life, all of which appear to dislike resinous matters. Thus in forest decomposition, as well as in peat, there is an increase of resinous matter due to the rapid dissociation of the woody fiber. I am giving attention to the decomposition of wood, as further experiments are wanted in this direction.

Turning to the tertiary formation of Bovey Tracey, it is found that, just as in the case of peat and wood decomposition, the lignites have an excess of resinous matter in them; and there is, moreover, a considerable quantity of resin in lumps unmixed with the lignite coal. This resin melts at a low temperature, and the strata do not show the effect of much heat. Hatchett named this resin "retinasphaltum," and it was further examined by the writer (Chem. Soc. Journal, 1877). The late Dr. Percy ("Metallurgy," vol. Fuel) mentions coals, apparently of tertiary origin, from New Zealand, etc., containing particles of resin. Dr. Hofmann, in his investigations upon the coals of Canada (Trans. Roy. Soc. Canada, 1889), showed that certain coals, chiefly of tertiary origin, contained grains of mineral resin disseminated through them. And Mr. Watson Smith (Journ. Soc. Chem. Ind., 1892, 1893) found in the Miike coal of Japan as much as 9·5 per cent. of bituminous matter. It must be inferred, therefore, that there is an accumulation of resinoid and bituminous matters in lignite coals, and it is a curious fact that the woody varieties, and even the "leafy" coal of Bovey Tracey, composed of branches and leaves in perfect preservation, contained resinous matters in large excess over that which could have been present in the vegetable material in its normal condition. The same is true of those beds of lignite which have all the appearance of compressed wood. And from a careful study of the Bovey Tracey lignites it is not only evident that conifers and other dicotyledonous trees flourished, yielding much resinous and terpene compounds, but that the condition of vegetation was such that liquid gummy and resinous matters were showered from some of the trees during the tertiary coal period. The yellow resin found in quantity in the Bovey Tracey formation shows that the resinoids in the "leafy" and "woody" coals are not the result of the melting and soakage of the accumulated resinoid matters. As it is admitted, unreservedly, that the Bovey coal is made up of conifers and dicotyledons, the above conclusions may not be much questioned; but what of the coals of the carboniferous age? Where would the showers of liquid gummy and resinous matters come from when the vegetation was monocotyledonous? Witham long ago pointed out the mistake which is frequently made to-day, and he showed, sixty years ago, that dicotyledonous trees formed a large portion of carboniferous coal, remarking, "I must contend that there existed coniferous trees, or such as contained a complicated woody structure in great abundance." More recent search has revealed, chiefly in the strata intermediate with the coal beds, many dicotyledons other than conifers; hence there is no evidence wanting to show that true wood formed a large share of the coal of carboniferous age. Mr. Hutton (Lond. and Edin. Phil. Mag., 1838) mentioned that he observed under the microscope that some of the coals of the North of England coal field contained minute grains of a yellow bituminous resinoid, so volatile as to be easily expelled by heat without altering the structure of the coal; and, since then, similar observations have been made.

THE LIGNITES OF BOVEY TRACEY, AND COALS OF THE SOUTH WALES FIELD.

Description.	Soft or hard.	Wet or dry.	Hygroscopicity.	Carbon.	Hydrogen.	Oxygen.	Nitrogen.	Sulphur.	Ash.
			Per cent.	Per cent. on dry sample.					
Soft lignite	Soft	Wet	15·0	59·9	6·0	25·0	0·6	1·5	7·0
Compact lignite	Medium	"	10·9	66·7	5·5	20·0	0·8	2·0	5·0
Upper carboniferous coal (Mynyddyslwyn)	"	Medium	6·0	79·5	5·5	4·5	1·5	3·5	5·5
Pennant coals	Hard	"	4·0	81·5	5·0	4·5	1·5	3·0	4·5
Semi-bituminous coal	"	"	2·5	84·3	4·5	4·0	1·3	2·0	4·0
Steam coal	"	Dry	1·5	87·8	4·2	3·0	1·0	1·0	3·0
Anthracite coal	Very hard	"	0·5	91·7	3·5	2·5	0·8	0·5	1·0

These facts show that what was true of the Bovey Tracey lignite formation is true also of coals of the carboniferous age, and there seems every probability that not only did conifers and other dicotyledonous trees flourish during the carboniferous period, but that much liquid gummy and resinous matters were showered from the trees upon the dried and decomposing material on the surface. It is well known that various trees, like the lime, for instance, during the flowering period, often shed enough saccharine matter to render its leaves and the grass underneath covered with the saccharine material; and not unfrequently coniferous trees, like the Scotch fir, shower terpenes and resinoid matters upon the ground beneath. It is to this behavior of tree life I attach much importance, as having a weighty bearing upon the chemistry of coal formation, not only during the tertiary, but also during the carboniferous age.

It has long been an enigma to botanists and geologists why the forms of the delicate ferns of the carboniferous coal period should be so perfectly preserved, while so little of the structure of the woody material is discernible. My opinion is that these ferns and delicate undergrowth, when dying and drying, became saturated with liquid resinous matters falling from the trees, and, in this way, were preserved from putrefaction, to imprint their beautiful forms upon the shale and rock above the coal, and in other positions.

From a careful consideration of the condition of vegetation during the carboniferous age, and the decomposition which ensued, I think that the chemical nature of coal, as we find it, is the result, not so much of heat and pressure and decomposition in its deeply buried condition, as upon the character of the primary decomposition which took place at or near the surface, together with the nature of the material from which the coal was formed.

Starting with the bituminous shales, like those used by the Young Candle Company, and at the Pumpherston Works in Scotland, I believe that there, as shown in the mineral strata, huge forests flourished from which the woody fiber was eliminated by surface decomposition, only resinoid matters remaining. The high percentage of mineral matter favors this view.

Resinous vegetation, without much dicotyledons, or if with dicotyledonous trees, much surface decomposition, by long continued exposure would produce Scotch cannel, rich bituminous coals, Wigan cannel, etc.

A luxurious resinous and dicotyledonous vegetation, without much surface decomposition, probably gave rise to semi-bituminous, steam, and anthracite coal, assisted, of course, by heat and pressure.

Now as to our present knowledge of coal itself.

1. It contains water, and retains some after long exposure in dry air. As shown in the table, the quantity of water retained by a coal after drying at ordinary temperatures is, as a rule, proportionate to the age of the coal—being highest in lignite and lowest in anthracite. Jet, and numerous coals of the carboniferous age in various coal fields, are exceptions to the rule. Some lignites contain 30 per cent. of water in the natural condition, but the better qualities do not hold more than 20 per cent., and this is reduced by air drying to 10 per cent. Such coals as are used for fuel in this country rarely hold more than 5 per cent. after being air dried. Coals which we ship abroad in their air-dried condition generally contain less than 3 per cent. of moisture; while steam and anthracite coal from dry seams do not hold more than 1 per cent. of moisture. Coals won from seams to which water gains access contain much larger quantities of water; but I am referring now to the hygroscopicity of coal.

The point I wish to emphasize is, not the quantity of moisture air-dried coal contains, but to call attention to how this moisture is held. If the water still retained in an air-dried sample of coal be driven off by heat, and the dried coal afterward exposed in a moist atmosphere, the moisture is reabsorbed at a very quick rate; and so great is the hygroscopicity of some coals that it is not possible to estimate the water in an open vessel, as the weighing cannot be done quickly enough to prevent reabsorption. Dr. Hofmann, of the Canadian Geological Survey, has shown that a portion of the water in coal is most obstinately held, and there is no doubt, I think, that it exists in chemical combination. In the deep dry steam and anthracite coals, as they occur in their seams, there is, probably, no moisture, but these are very hygroscopic to a certain point, and in the analyses of coal the hygroscopicity has not received due attention. Furthermore, it seems to me that the hygroscopicity of coal is the key to the property of spontaneous combustion, and should be made the subject of further experiment.

2. Coal contains the gases, oily matters, and solids of the paraffin series. In my experiments on the gases inclosed in various coals I obtained gases and liquids of the paraffin series, and, in one instance, white solid paraffin from a coal of carboniferous age. Mr. Watson Smith's experiments (Journ. Soc. Chem. Ind., 1893) show conclusively that liquid and solid paraffins exist ready formed in coal, but they rarely exceed 1 per cent. in coals of the carboniferous period.

3. Coals contain 0·5 to 10 per cent. of ash or mineral matter in good samples, and from 0·5 to 4 per cent. of sulphur, generally present as disulphide FeS_2, in coals of carboniferous age. In lignites it frequently occurs in organic combination.

4. The bulk of coal consists of carbon, hydrogen, and oxygen, with from 0·5 to 2 per cent. of nitrogen. How the nitrogen is combined is not known. The same remark applies to the carbon, some of which doubtless is in combination with hydrogen. How much of the carbon is free and how much is in combination with hydrogen will, most probably, never be known. The oxygen is generally regarded as being combined with hydrogen, but I do not think that this is the case with the dry deep coals containing occluded marsh gas; some oxycarbon compound containing hydrogen is probably the condition.

In conclusion, I suggest that further experiments be made in the following directions:

1. Upon the decomposition of dicotyledons with a view to throw light upon the formation of coal.

2. Upon the hygroscopicity of coal; and to study its bearing upon the spontaneous combustion of coal on board ship.

3. Upon the coals from all the British coal fields to determine the quantity, and, if possible, the constituents soluble in gasolene (petroleum ether), or benzine, as employed by Mr. Wilson Smith.

4. To act upon the various coals with a weak solution of potassic hydrate.

* A paper read before the British Association (Section B), Oxford meeting, 1894.

THE PTOMAINES FORMED DURING PUTREFACTION.

By C. A. MITCHELL, B.A. Oxon.

SELDOM does a year pass without the medical journals recording several cases of poisoning whose cause can only be traced to the eating of unwholesome meat or fish. It is no uncommon thing to hear of whole families suffering from the effects of eating mussels, while tinned meats and sausages are also sometimes found to be most dangerously poisonous. Sometimes the attack ends in death, as in the case mentioned by Czraut in his "History of Greenland," where thirty-two persons died from eating the brains of a walrus which had begun to decompose. In other instances only temporary indisposition is the result, even when a large quantity of the substance has been eaten. These symptoms, whose origin was formerly quite obscure, are now believed to be due to the presence of one or more of the ptomaines or animal alkaloids.

The name "alkaloids" was formerly confined to the complex nitrogenous bodies formed under normal circumstances by the vegetable protoplasm of certain plants, and containing, in addition to nitrogen, varying quantities of carbon and hydrogen, and in some cases oxygen. They may be solid and crystalline like strychnine, or a volatile liquid like nicotine, the alkaloid contained in the tobacco plant. They are more or less soluble in water, combine readily with acids to form salts, and have characteristic test reactions by which they can be distinguished from other bodies containing the same elements arranged in a different manner. Many of them act as deadly poisons on the animal system.

A similar class of substances is formed in living animals by the chemical processes of the body; these have been called leucomaines, while the alkaloids formed after death in the course of putrefaction have received the name of ptomaines. The leucomaines, of which the first known were extracted from normal tissue by Gautier in 1886, are in many cases non-poisonous, though some which have been prepared from the saliva and urine have proved fatal when injected in small quantities into animals. In composition they are, as a general rule, less complex than the ptomaines, though this distinction cannot be rigidly maintained. Brieger and others* do not allow their separate existence, and assert that they are not formed in the living body, but are ptomaines absorbed from the intestinal canal. The general consensus of opinion, however, seems to be against this view.†

That poisonous principles could be extracted from decaying meat was known long ago, but our knowledge of them is quite recent. In 1856, Prof. Panum, of Copenhagen, extracted from the flesh of dogs a poisonous substance which he called "putrid venom," and afterward sepsin. The name ptomaines ($\pi\tau\omega\mu\alpha$—a corpse) was first used in 1875 by Selmi, of Bologna, who applied it to a mixture of alkaloidal products which he had separated from the putrefying remains of dead bodies. It has since become the general term for these products. It used to be thought that these animal alkaloids were different in kind to those formed in the vegetable kingdom,‡ but recent research has proved that they closely resemble each other in their properties, and are in some cases of apparently identical chemical composition.§

Brieger, to whom we owe much of our knowledge of the subject, defines the ptomaines as "all nitrogenous bases formed by the action of bacteria," but it is more usual to confine the term to those products formed during putrefaction. This process, as was shown by Pasteur in 1863, is a species of fermentation carried on

* E. g., Bouchard and Schar.

† Cf. Sir William Aitken's Animal Alakaloids; Gould's Medical Dictionary, 1890; Pouchet in Dict. Encycl. des Sciences Medicales.

‡ P. Spicca, Gazetta, ii., 486-487.

§ Aitken, Animal Alkaloids.

by micro-organisms derived from the air. It is a property of vegetable and animal nitrogenous substances, and is the natural chemical sequel to life. After death, unless artificial means of preventing it occur, the work of splitting up complex substances into simpler and more stable forms commences. As Huxley says: "Tendency to equilibrium of force and permanency of form are the characters of that portion of the universe which does not live." Liebig's theory, that blood would not undergo putrefaction if protected from air germs, has since been again and again verified by only allowing access to air which had been sterilized by heating or filtration. Heating on successive days in steam or by dry heat at a higher temperature will destroy bacteria, or they may be removed by drawing air through cotton wool, which will retain them; and Tyndall's experiments also proved that organic matter protected from micro-organisms would not putrefy. In this work of disintegration two classes of organisms bear part—the aerobic, which require the presence of oxygen, and the anaerobic, to which that gas is fatal. After death the body becomes a suitable culture medium for the reception of the anaerobic bacteria (vibriones) with which the air swarms. Some of these falling on the body draw their nourishment from the albuminous substance, splitting it up into simpler forms, and thus produce putrefaction. To complete the work of destruction the assistance of aerobic organisms is essential, for the vibriones, living without oxygen, sooner or later perish, and are themselves oxidized. Oxidation is the name given to the chemical process in which substances combine with oxygen. Since about one-fifth of the atmosphere is composed of this gas, the process is continually going on in nature. Familiar examples of it are the rusting of iron and the burning of wood, where the heat enables the carbon and hydrogen in the wood to enter into combination with the atmospheric oxygen. The aerobic organisms which complete the work belong to the class of moulds, and on their advent the oxidizing process continues until the whole substance is transformed into the final simple and stable forms.

The mechanical process of putrefaction was studied by Gautier and Etard in 1882.* Muscles of beef and horseflesh, which were odorless and having a slight acid reaction, were exposed to the action of putrefactive organisms. After a time, there was an acid odor, and a clear, serum-like fluid exuded. This apparently coincided with the commencement of fermentation. Large bacilli were present, and the gases given off were ammonia and carbonic acid, with a little sulphureted hydrogen and phosphureted hydrogen. Toward the fourteenth or fifteenth day free nitrogen began to be given off, and at this point putrefaction proper commenced. The large bacteria disappeared, being replaced by very small ones, which attacked the albuminoid substance, liberating carbonic acid gas and ammonia, and quickly causing the mass to become alkaline.

The germs producing putrefaction are in themselves harmless, and the poisons produced during their work are formed either by alterations in the substances on which they feed or by their secreting some chemical product. Prof. Burdon Sanderson has shown that when dead matter, such as blood serum, is deprived of every trace of living organism, it still possesses the power of producing disease when introduced into the blood of animals.

Brieger† used the following method for extracting the ptomaines from human bodies: parts of the internal organs were placed in a cold cellar for from twenty-four to forty-eight hours. The mass was then made slightly acid with hydrochloric acid, heated nearly to boiling, and concentrated by evaporation. Alcohol was added to extract the alkaloid, which was then precipitated by platinic chloride. Alkaloidal bodies are readily dissolved by alcohol, and by filtration after treatment. With this the ptomaine would to a great extent be separated from other animal products. On now adding to the clear filtered liquid a solution of platinum chloride, which combines with alkaloids, a compound containing the ptomaine, insoluble in the alcohol, would be formed. This, filtered off, would leave most of the impurities still dissolved in the alcohol. From this combination the ptomaine choline was easily separated. If the putrefaction was allowed to proceed further, other ptomaines besides choline were formed.

Like the vegetable alkaloids, some of the ptomaines contain no oxygen, while others have four or six atoms in the molecule. The term "atom" is a theoretical term to denote the smallest particle of a substance—that which cannot be divided any more. A "molecule" may be defined as the smallest particle of a substance capable of separate existence. There are usually two or more atoms in a molecule.

Mytilotoxine, the alkaloid separated by Brieger from putrefying mussels, may be taken as a typical ptomaine. Its percentage composition is:

Carbon	58·5
Hydrogen	4·0
Nitrogen	11·5
Oxygen	26·0
	100·0

Other well-defined animal alkaloids are neurine, which, like choline, is found in putrid flesh, and tyrotoxicon, which occurs in milk, and was the alkaloid separated in a case of poisoning by ice cream.‡

Most of them are extremely poisonous, and very minute injections have proved fatal to birds and small animals. The general symptoms are increased activity of the secretive organs and slowness of the heart's action, often followed by convulsions, paralysis, and death. In some of the cases of poisoning by putrid fish, there has been dilatation of the pupil of the eye and double vision. The action of neurine is stated to be very similar to that of curare.§

Closely allied to the ptomaines in composition are the products formed by the pathogenic bacteria; they are termed albumoses, and may be obtained from pure cultivations of disease organisms after removal of these organisms by filtration through porous porcelain. Disease organisms are cultivated outside the body by introducing a fragment of diseased tissue or blood containing the organisms into a tube in which is some medium, such as gelatine, on which the bacteria can grow. When such a "colony" is obtained, containing only one species of micro-organism, it is called a "pure cultivation." It is highly probable that these albumoses are the poisons by means of which the bacteria produce certain diseases, for inoculation with them has produced results in some instances analogous to those obtained by inoculating with the bacteria themselves. Many of them are named after the disease with which they appear to be connected. Thus we have diphtheridine, obtained by Loffler from the pure cultivation of the diphtheria bacillus, and scarlatinine and puerperaline connected with scarlet and puerperal fevers. Quite recently* Dr. Griffiths stated that he had isolated an albumose which he believed to be connected with influenza. It was a white substance, crystallizing in needles, soluble in water, and having a slightly alkaline reaction. Injected, it was extremely poisonous, producing much fever, followed by death in eight hours. Whether it really is a cause of influenza requires corroboration, and indeed the whole subject is one in which further investigation is needed.—Knowledge.

* Comptes Rendus, 1882.
† Ber. Deut. Chem. Ges., 17, 2741-2742.
‡ Pharm. Journ., 1887.
§ Aitken, Animal Alkaloids.

CHEMISTRY AT THE BRITISH ASSOCIATION.

THE meeting of section B at Oxford, Nature says, will be remembered as one of quite exceptional interest. That portion of the president's address urging upon the University fuller recognition of the claims of science in their curriculum will doubtless have valuable results. Certain of the communications brought forward in the course of the meeting may be described as epoch making. The presence of a large number of eminent foreign chemists served further to render the proceedings memorable and attractive.

The committee for preparing an international standard for the analysis of iron and steel reported that their work was now completed and that it is proposed to shortly deposit the standards with the Board of Trade, or with some other suitable authority where they will be at the public service. Prof. Clowes gave an account of his experiments on the proportions of carbonic acid in air which are extinctive to flame, and which are irrespirable. He finds that the flames of candles, oil, paraffin and alcohol are extinguished by air containing from 13 to 16 per cent. of carbonic acid. The flame of coal gas, however, required the presence of at least 33 per cent. of the extinctive gas, and the flame of hydrogen was not extinguished until the amount of carbonic acid in the air reached 58 per cent. Comparing his experiments with those of Mr J. R. Wilson on the percentage of carbonic acid required to suffocate a rabbit, Prof. Clowes concludes that air containing at least 10 per cent. of carbonic acid more than is required to extinguish a candle flame can be breathed with impunity. By taking advantage of the extraordinary vitality of the hydrogen flame in presence of high proportions of carbonic acid, it is possible to maintain the flame of the composite safety lamp (previously described by the author) after the oil flame has been extinguished.

Mr. Haldane concluded from some experiments he has made on the respirability of air containing carbonic acid that the percentage of this gas considered by Prof. Clowes to be respirable is too high.

Much interest was shown in the successful experiments of Dr. Lobry de Bruyn, demonstrating the properties of free hydroxylamine. On heating a small amount in a test tube, a sharp explosion took place. Left exposed to air, it was shown by its action on iodized starch paper to have become converted into nitrous acid. In a series of test tubes its behavior with various reagents was demonstrated. With potassium permanganate and with chromic acid oxidation took place, accompanied by flame; potassium bichromate produced an explosion. The anhydrous sulphates of copper and cobalt were reduced by the substance. Free hydroxylamine was dissolved in anhydrous ether and sodium added, hydrogen was evolved and the very explosive sodium compound of hydroxylamine produced. Chlorine and iodine were shown to act spontaneously on hydroxylamine, producing inflammation. It is of interest that hydroxylamine will dissolve many salts which are soluble in water, the order of solubility differing in the two solvents.

Dr. Bernthstein described a new bacterium which occurs in milk, whose chief property is that of peptonizing the caseine, thus forming a soluble compound, and rendering the milk transparent, and more readily digested.

A discussion took place on the behavior of gases with regard to their electrification, and the influence of moisture on their combination. It was opened by Prof. J. J. Thomson, who exhibited some brilliant experiments illustrating the connection between chemical change and electrical discharge through gases. The gases were confined, under a pressure of about 100 mm., in glass bulbs which were placed in the center of a coil of wire connecting the exterior of two Leyden jars, the interior coatings of which were connected with the two poles of a Wimshurst machine. As each spark passes between the poles of the machine, a rapidly alternating current is set up in the coil, and hence by induction in the gas. In the case of oxygen it was found that the moist gas gives a vivid incandescence, followed by an afterglow or phosphorescence, on removing the bulb from the coil. With the dry gas, on the other hand, incandescence does not take place. The incandescence can, however, be started in the dry gas by a brush discharge, and if once started, continues under the influence of the induced current. With air the phenomenon is reversed; damp air does not glow, dry air will. By making use of two coils in one of which was a beaker of fairly strong sulphuric acid, and in the other a bulb containing moist oxygen, the presence of the acid was shown to prevent the incandescence in the bulb, showing the conductivity of the gas to be much greater than that of the acid. As the glow is only given in gases forming polymeric modifications, it is suggested by Prof. Thomson that the drops of water present may act as conductors, causing the original molecules to dissociate. In the case of dry gases this preliminary dissociation can only be brought about by expenditure of a large amount of energy. Alcohol vapor will behave similarly to water, and it becomes of interest to study other solvents.

Mr. Brereton Baker followed with some experiments on the influence of moisture on chemical substances. He showed that ammonia and hydrochloric acid when dry do not combine. He also exhibited tubes containing dry sulphur trioxide and cupric oxide, and dry sulphur trioxide and lime side by side, without action upon one another, a kind of "chemical happy family," as he expressed it. He concludes that the function of moisture is physical rather than chemical, from the fact that on heating together a dry mixture of cupric oxide, carbon and oxygen, no action takes place. He has obtained analogous results to Prof. Thomson, by using semi-vacuous tubes, into one end of each of which a platinum wire is fused and which contain a small quantity of mercury. On shaking these tubes in a dark room incandescence takes place in those containing moist oxygen. This is less if nitrogen is present, and ceases if the gas is dry.—Dr. Ewan read a paper on the rate of oxidation of phosphorus, sulphur and aldehyde. The results obtained with aldehyde are free from the uncertainty produced by the correction for the changing rate of evaporation. When proper precautions are taken, this reaction goes perfectly regularly at 20°, and its velocity is proportional to the product of the pressure of the aldehyde and the square root of the pressure of the oxygen. These results are most simply explained by assuming (in accordance with Williamson's theory) that the oxygen first splits up to some small extent into atoms, and that these alone take part in the oxidation.

Prof. Hartley described some new methods of spectrum analysis and some Bessemer flame spectra. He has found that if a mixture containing alkalies and alkaline earths be fused with borax or silica, the alkalies are first volatilized and give their characteristic spectra very clearly. For obtaining spectra at high temperatures it has been found useful to heat the substance in the oxyhydrogen flame on a rod of kainite, pipe clay, or dried alumina. The elements can be classified according to the type of spectrum given under these conditions. On vaporizing alloys, those constituents which, when free, give band spectra, are found to produce line spectra, e. g. silver, in an alloy of copper and silver. This is thought to be due to the difference between the vapor pressure of the element when alloyed and when in the free state.

A large audience assembled to hear the announcement by Lord Rayleigh and Prof. Ramsay of the existence of a new gas in the atmosphere. It appears that certain experiments of Cavendish pointed to the presence, in air, of some substance other than the gases with which we are familiar. Attention was recalled to this substance by the fact that the density of nitrogen obtained from atmospheric air differs by about ½ per cent. from the density of nitrogen obtained from other sources. It was found that if air (with excess of oxygen) be subjected to electric sparks, the resulting nitrous fumes absorbed by potash, and the excess of oxygen by alkaline pyrogallate, their remains a residue which is neither oxygen nor nitrogen, as can be seen from its spectrum. The same gas can be isolated by exposing nitrogen obtained from air to the action of magnesium. As the magnesium gradually absorbs the nitrogen, the density of the residual gas gradually rises to nearly 20. The newly discovered substance constitutes nearly 1 per cent. of the atmosphere, and gives a spectrum with a single blue line much more intense than a corresponding blue line in the nitrogen spectrum.

Sir H. E. Roscoe, in proposing a vote of congratulation on the discovery, spoke of the special interest which attached to it as being the outcome of a purely physical observation.

Prof. Emerson Reynolds noted the place which the new substance, if it proved to be an element, would occupy in Mendeleeff's table among the platinum metals.

Prof. Roberts-Austen suggested that this gas might be the one which is frequently found as a residue among the gases extracted from steel.

The president, in putting the vote of congratulation to the meeting, drew attention to an observation made by Prof. Dewar, that while a mixture of pure liquefied oxygen and nitrogen forms a clear liquid, air in a similar state shows a turbidity. The president suggested that this turbidity might be due to the new gas.

Some very interesting experiments on the electrolysis of glass were described by Prof. Roberts Austen. In conjunction with Mr. Stansfield he has found that if a bulb of soda glass be filled with sodium amalgam and immersed in a vessel of mercury heated in a sand bath to rather over 200°, on connecting the sodium amalgam and the mercury respectively with the terminals of a battery, sodium will pass from the amalgam through the glass into the mercury. At the end of the experiment the glass is unchanged. If lithium amalgam be substituted for the sodium amalgam, however, a certain percentage of lithium is found in the glass at the end of the experiment, sodium from the glass is driven into the mercury, and the glass is altered in appearance and frangibility. With potassium amalgam and soda-glass no change takes place. These phenomena are believed by Prof. Roberts-Austen to depend on the relative atomic weights and consequent atomic volumes of the elements concerned. Lithium, having a smaller atomic volume than sodium, is able to follow in the galleries left by the atoms of the latter metal; potassium, on the other hand, having an atomic volume greater than sodium, cannot force a passage. From the results he has obtained, using other amalgams, such as those of gold and copper and different kinds of glass, Prof. Roberts-Austen hopes to throw light on the formation of mineral veins in rocks which apparently have not undergone fusion.

REFINING OF CARBON BISULPHIDE.

By J. FARBAKY.

RAW carbon bisulphide is contaminated with from 6 to 10 per cent. of dissolved sulphur, and in consequence of this and other impurities has a brownish color and a penetrating odor. The redistillation in order to purify the chemical has since 1888 been performed successfully by a continuous process. For this purpose an iron vessel is used having a circular cross section and provided with a wooden jacket. It is 155

*Chemical News, Nov. 17, 1893.

cm. high and 180 cm. broad. The space between the wooden jacket and the iron still is filled with ashes to the exclusion of the air. A temperature of 48° C. is required for the distillation, and is produced by the introduction of steam between a double base or bottom.

The vapor of the carbon bisulphide passes off through a tube and is condensed in a row of four cooling tubes, which are surrounded by water. The carbon bisulphide is collected beneath water. The filling and clearing of the vessel may be accomplished by means of a small aperture at the top of the vessel. In charging, 40 to 50 hectoliters of raw carbon bisulphide are placed in the vessel, and steam used at about 0·3 to 0·5 atmospheric tension. About two hours after, the distillation commences, which is very strongly evidenced by the heat of the exit tube, while a hissing is heard in the condenser, sulphureted hydrogen being also liberated at the earliest stage of the operation. The refining process lasts about six hours. The residual sulphur in the vessel must be cleared out with a wooden scoop. It is in this operation that the workman is exposed to the escaping vapors of carbon bisulphide, and is thereby very seriously affected. The destructive reaction of carbon bisulphide upon the organism is indeed so considerable that, as Clocz states, as small a volume as 5 per cent. of the vapor in the air is sufficient to kill the smaller mammalia, as well as birds and reptiles. The workman suffers from headache, vomiting, and has irresistible fits of weeping, soon feeling violent pains in his limbs, chiefly in the legs, and finally all his bodily and mental powers are paralyzed or much impaired, and loss of memory is noticed to ensue. It has happened even that the workman lapses into idiocy.

It has been tried to expel the CS_2 and other substances present out of the residual sulphur by raising its temperature considerably. But as the vessel can only stand a pressure of half an atmosphere, the difficulty is overcome in another manner. The vessel is filled three parts with water and steam let directly into the liquid. The water is brought up to boiling, and the carbon bisulphide is thus distilled over. The heating occupies about 20 hours, whereupon the water can be drawn off and the sulphur removed without any danger. This residual sulphur is used up again in the raw production of the carbon bisulphide.

The refined carbon bisulphide is removed 15 hk. at a time and stored up under water in sheet-iron cylinders holding about 30 to 80 hk. The supply is executed in 500 or 100 kilogramme lots, in wrought iron and air-tight cylinders. For the first quantities a space of about 12 liters, for the latter 2·5 liters, to allow for the expansion of the carbon bisulphide.

The total production of the refined carbon bisulphide is taken over by the Hungarian Agricultural Secretary of State for 18 florins per hectoliter and distributed among the schools for vine culture and other economical associations as a destructive agent against phylloxera.

The cost of production is from two to three florins (four to six shillings) per hectoliter. Up to 1889 only one of the two retorts available was used at a time, but since the enlargement of the works the process is generally carried on in three retorts out of four simultaneously.

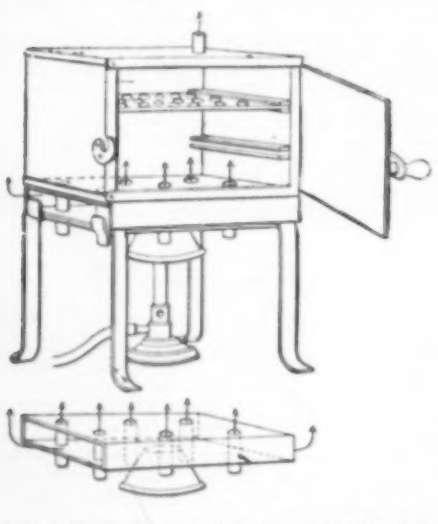
The annual production of raw CS_2, with one oven, is 1,102 hectoliters. The total production per annum can therefore be estimated at $4 \times 1,102 = 4,408$ raw or — taking the pure at 80 per cent. — at 3,500 hectoliters, which corresponds approximately to the present consumption in Hungary.

The production of the raw CS_2 is a very complicated and dangerous process, so much so that at first the utmost difficulty was experienced to obtain any workmen to perform the operation. Besides the use explained in this article, it is also used for the extraction of oils from seeds, etc., solution of resinous substances, alkaloids, phosphorus, and sulphur.—Zeit. f. angw. Chem.

A NEW FORM OF AIR BATH.

By E. SAUER. J. Amer. Chem. Soc.

IN order to insure a constant temperature, which shall not be limited by the boiling point of some liquid

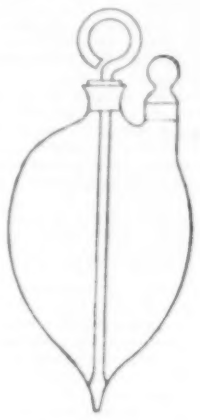


contained in an outer jacket, the author has devised the form of air bath shown in the figure. The bath has a false bottom, perforated to allow a series of tubes to connect the inside of the oven with the outside air beneath the apparatus through the real bottom; the latter, in addition to corresponding perforations, has a larger central aperture through which the flame of a Bunsen burner can play upon the false bottom and around the connecting tubes; the products of combustion pass away through the sides of the lower chamber between the two perforated plates, the sides being left open. Evaporation is facilitated by the rapid renewal of the atmosphere within the bath by means of the tubes; and experiments are quoted to show that not only is evaporation rapid, but the temperature at different points of the bath is very uniform.

DROPPING FLASK FOR STANDARD SOLUTIONS.

By F. VANDERPOEL. J. Amer. Chem. Soc.

THE use of burettes for standard solutions involves serious errors (e. g., such as arise from alterations of temperature), which can be avoided by substituting

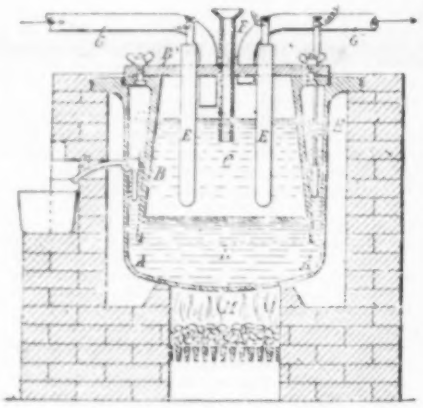


weighing for measuring. The figure shows a simple form of dropping flask for standard solutions, which has been found convenient. The figure is almost self-explanatory. It suffices to say that the central rod is of glass, and passes through a cork in the upper tubulus of the flask, and is ground into the lower exit tube, thus serving to regulate the outflow. The side tubulus is used for filling the flask. The whole apparatus can be slung to a hook on the balance, or supported on a light tripod in the manner of a weighing bottle.

IMPROVEMENTS IN THE PRODUCTION OF CHLORINE AND REFINED LEAD AND RECOVERY OF SILVER.

By F. M. LYTE, London.

LEAD chloride is formed from yellow lead oxide (preferably) or from lead oxychloride, by grinding



with an excess of aqueous hydrochloric acid, in a pan having a granite bottom and stoneware sides; or enameled metal pans may be used, an example of which is shown, in which stone mullers are carried round by cross arms and stay rods of a frame revolving on a center, and resting at their outer ends on rollers on a circular rail supported by adjusting screws to regulate the grinding action. Silver chloride may be dissolved out of the product by strong hydrochloric acid or solution of a suitable alkaline-earthy chloride; and on filtering the warmed solution through spongy lead, silver is deposited. Or the argentiferous lead chloride may be fused over lead, the chlorides being used in successive charges until the lead is sufficiently enriched for recovery of the silver by cupelation.

Crude lead may be oxidized in a basic-lined Bessemer converter, in which a high temperature is attained, and the silver becomes concentrated in the small proportion of lead that escapes oxidation. The last traces of silver may then be recovered from the litharge and fume in the manner first described.

Lead chloride may be purified by solution in hot water and crystallization, the same water or mother liquor being repeatedly used. The chloride is then washed, dried, fused and electrolytically decomposed in the fused state, to obtain lead and chlorine, in the apparatus represented above.

The iron pan, A, set over the furnace, M, contains lead, L, into which the earthenware or plumbago bell, B, dips, the lead being melted to receive it, and then allowed to set, while the bell is charged with lead chloride by removing the cover, B¹, and afterward with successive additions through the inlet, F. E E are carbon anodes, each hollowed to receive a fusible metal core, preferably of lead, connected to the conducting wires. H is the cathode terminal dipping into the lead, L. As the molten lead increases by decomposition of the chloride, it runs off by the pipe, D. The apparatus shown is intended for connection in series, the chlorine entering from another cell by the pipe, G, and having outlet by the pipe, G¹. It is a feature of the invention that the air in the cell should be displaced by a non-oxidizing gas, as chlorine or nitrogen, in order to avoid any formation of lead oxide in the process.

FLAMES IN FOUL AIR.

AT the last meeting of the Federated Institution of Mining Engineers, Dr. Frank Clowes read a paper on "The Proportion of Carbon Dioxide (Choke Damp) in Air which is Extinctive to Flame." It contained a suggestion of a method for ascertaining the limit of safety of mixtures of carbon dioxide and air. It appears from Dr. Clowes' own experiments, in which the effect of atmospheres containing known proportions of carbon dioxide was determined from a variety of naked flames, that candles and ordinary lamp flames, inclusive of colza and petroleum and ordinary lamp paraffin, cannot live in an atmosphere containing from 14 to 16 per cent. of added carbon dioxide. On the other hand, the flame of burning hydrogen is not extinguished until 58 per cent. of carbon dioxide has been added to the air; and coal gas will burn with 33 per cent. of added carbonic acid. Methane will only stand 10 per cent., while carbonic oxide will endure 24 per cent. of the same addition. The author exhibited a lamp in which a flame of hydrogen was burning at the side of an oil flame, and he showed the superior endurance of the former when exposed to vitiated air. He concluded by remarking that the wisdom of attempting to pass through foul air in mines, wells, etc., has been questioned, because it has been assumed that an atmosphere which contains sufficient carbon dioxide to extinguish the oil flame of a safety lamp would necessarily be irrespirable, or at least dangerous to life. Experiments recently conducted by Mr. T. H. Wilson, however, have gone to prove that rabbits can breathe with impunity for an hour at least air containing 25 per cent. of carbon dioxide. The presence of 16 per cent. of this impurity extinguishes the ordinary safety lamp flame. Hence it appears that respiration can be maintained unimpaired in air containing at least 10 per cent. more choke damp than is sufficient to extinguish the oil or alcohol flame of a safety lamp. If Mr. Wilson's experiments are accepted, it would evidently be well to have some test less sensitive than the ordinary safety lamp flame to indicate whether an atmosphere contains sufficient carbon dioxide to be dangerous to life. Since the flame of ethylene is only extinguished with 26 per cent. of added carbon dioxide, such a flame might serve the purpose. It is worthy of notice, in this connection, that a naked coal gas flame will seemingly continue to burn in air that has long passed the limits of added carbon dioxide compatible with the preservation of human life.

THE ALKALOIDS OF COD LIVER OIL.

AMONG the exhibits in the museum at the recent meeting of the British Medical Association, Bristol, a particularly interesting specimen was a substance exhibited by Messrs. F. Stearns & Co., of Detroit, under the name of "Panjecorine." As the name signifies, this was a specimen of the total alkaloids contained in a sample of cod liver oil. This subject was first taken up by MM. Gautier and Mourgues, who published in 1890 (Journ. de Pharm., March, 1890) a detailed account of their experiments and the substances extracted by them from the oil. These were butyl, amyl, and hexyl amines, dihydrotoluidine, aselline, morrhine and morrhuic acid (the gaduine of De Jongh); the latter two being the most important bodies. In reply to charges that these bodies were probably decomposition products, an article appeared in the Comptes Rendus (November, 1892), from the pen of M. Bouillot, showing that by the aid of gaseous hydrochloric acid and platinum perchloride the alkaloidal bodies could be crystallized in situ in the fresh liver, and their form identified with that of the bodies extracted from the oil. Microscopical drawings of the principal active bodies are shown below. The subject is being followed up by Professor Schlotterbeck, of the University of Michigan, who has confirmed the results of MM. Gautier and Mourgues, and who prepared the specimen exhibited at Bristol. Up to the present a ready method of separating the various constituents from each other has not been found, but there does not appear—at all events as far as the medical activity of the bodies is concerned—to be any necessity for separating

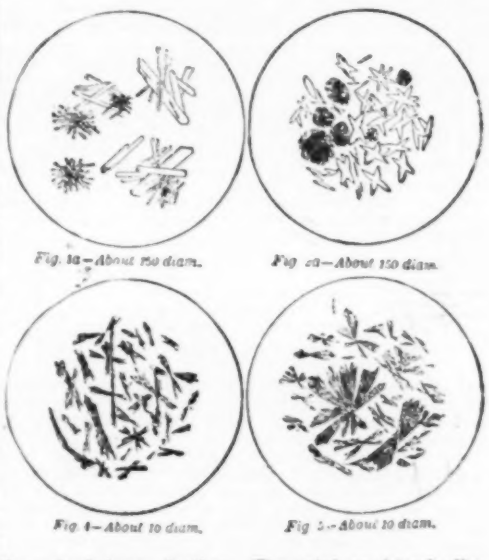


Fig. 1a—About 150 diam. Fig. 2a—About 150 diam.

Fig. 4—About 10 diam. Fig. 5.—About 10 diam.

the mixed bases further. The total combined alkaloids or "Panjecorine" have so far proved to be quite equal to the cod liver oil itself, but it has not yet been proved whether or not the residual oil has any medicinal value. Professor Schlotterbeck is preparing a further paper for the forthcoming meeting of the American Pharmaceutical Association. The combined alkaloids are readily soluble in dilute alcohol, and Messrs. Stearns are utilizing this property in preparing a wine of cod liver oil, which clinical reports state to be quite as valuable as the oil itself, while free from its unpleasant taste.

THE CHOLERA IN RUSSIA.

THE cholera that has just broken out in Russia threatens to claim more victims than it did last year. According to the several times secular habit, at every scourge that Russia experiences (inundation, famine or epidemic), solemn prayers have been offered up throughout the entire empire. From the consecrated sanctuaries of Moscow and Kiev (the holy cities), down to the most humble village church, there is no bell that has not rung in order to assemble the faithful around holy images and the blessed paten that the whole population of the parish comes to kiss.

In the quarters in which the epidemic prevails with the most violence, the clergy passes in procession with banners bearing the images of saints and figures or altar pieces that encircle the face of God the Father, of Christ and of the Virgin with aureolas or rays of goldsmith's work studded with jewels. The priests enter for an instant the houses in which there are known to be either sick or dead persons, carry the holy images in with them, and sprinkle the walls and the inhabitants with holy water; while in the street, in front of the door, the passers-by stop, uncover their heads and make multiple signs of the cross, and often kneel, even, and join their prayers with those of the priests.

A grand religious ceremony took place not long ago in front of the cathedral of Kazan, at St. Petersburg, in order to exorcise the cholera, which has made numerous victims there during the last few weeks.

THE CHOLERA IN RUSSIA—PUBLIC PRAYERS TO AVERT THE DISEASE, IN FRONT OF THE KAZAN CATHEDRAL, ST. PETERSBURG.

The cathedral, which was erected to Our Lady of Kazan, possesses nothing of the Russian style. By one of those infatuations with occidentalism of which the public buildings of St. Petersburg offer so many examples, this orthodox church has nothing of the Byzantine about it; it is wholly Roman. Half of the colonnade, the portico and the cupola reveal an exact copy of St. Peter's at Rome, but a St. Peter's in miniature, which produces the most singular effect when one has in memory the gigantic proportions of the model, and before his eyes the seemingly infinite Newski perspective back of where this church stands.

The ceremony brought together upon the place surrounding the colonnade an immense crowd, but one full of meditation mingled with curiosity, which is far from the fervor of the Russia of the holy cities or of the peasant. We see that St. Petersburg is a window open upon Europe. A fresh breeze enters through it, and one becomes calm over external demonstrations, genuflexions, signs of the cross and prosternations. It is only with head uncovered and slightly inclined, among the most fervent, that a line is formed upon the passage of the metropolitan Palladius, who advances miter upon head under illumined banners, in the midst of his clergy and his chanters.—L'Illustration.

ONE of the oldest and most curious examples of the locksmith's art is attached to the door of Temple Church, Fleet Street, London. The key weighs seven pounds, is eighteen inches long, and, unlike other keys, it was not made for the lock. On the contrary, the lock was made for it.

THE THYROID AND THE PANCREAS.

IT has been found in the case of the thyroid gland that patients in which this structure has been so diseased that its function is seriously interfered with, and animals in which it has been removed entirely, may be greatly benefited, if not indeed cured, by the inception, either subcutaneously or with food, of the thyroid glands of animals, or of the juice of such glands. Even where no affection of the thyroid can actually be detected, the exhibition of thyroid juice is frequently beneficial in certain conditions of the system, and it was noticed by Dr. Oliver, of Harrogate, that this is especially the case where there is a too marked constriction of the blood vessels, the juice of this body tending in such cases to reduce the extreme tone of the vascular walls which is the cause of this condition. Encouraged by this result, Dr. Oliver was led to examine the effects of other animal extracts, and among them that of extract of supra-renal capsule. The effect of this was precisely the reverse of that which he had got with the thyroid body, for he obtained evidence tending to show that in certain cases in man extract of supra-renal capsule can produce an increase of vascular tone and a diminution in the size of the arteries. Beyond this point, however, Dr. Oliver was unable to proceed by clinical experiment, and he accordingly came to my laboratory with the object of determining the precise physiological effect of the active substance of the capsules. The results which were obtained show that there is present in both alcoholic and watery extracts of the gland a most potent physiological substance, which, when injected into the body of an animal, produces, even in minute doses, a remarkable effect upon certain parts of the nervous system, upon the muscular system, upon the heart, and upon the blood vessels. If only as much as a grain by weight of supra-renal capsule be extracted with alcohol, and if this alcoholic extract be allowed to dry, and then be redissolved in a little water or salt solution and injected into the blood of a dog, the results which are obtained, considering the minute amount of substance added to the blood, are certainly most extraordinary. The nervous center which regulates the action of the heart is powerfully affected, so that the heart either beats very slowly and weakly or the auricles may even for a time stop beating altogether. If, however, these inhibitory influences be cut off by division of the vagi nerves, the effect of the poison upon the heart is of an opposite character. There is great acceleration of the rate of the beat and a great increase of force. This is accompanied by a strongly marked influence upon the blood vessels, and especially upon the arterioles. The walls of these are chiefly muscular, and the drug exerts so powerful an action upon this muscular tissue as to cause the caliber of the vessels to be almost obliterated. The heart being thus increased in force and accelerated, and the caliber of the vessels almost obliterated, the result is to raise the pressure of the blood within the arterial system to an enormous extent, so that from a blood pressure which would be sufficient to balance a column of some four inches of mercury the pressure may rise so high as to be equal to a column of mercury of twelve or more inches.

This result is obtained, as we have seen, by a very minute dose. We have to do here with a substance which is as potent, although in a different direction, as strychnia. Whether it is a useful substance formed by the supra-renals from materials furnished by the blood, and subsequently gradually used in the economy for the virtue of its action upon the circulatory system, or whether it is to be regarded as a poison formed by the tissues during their activity and carried by the blood to the supra-renals, there to be rendered innocuous, we do not as yet certainly know. These are important points which must form the subject of further investigation. But, however this may be, it is clear that in this gland also we again meet with an instance of the physiological importance of what Sir Frederick Bramwell called the "next to nothing."

THE PANCREAS.

I will give one more instance, taken this time from a gland which is provided with a duct. Until quite recently it might have been thought that there was nothing very obscure regarding the functions of the pancreas. The pancreas is a digestive gland which lies below and behind the stomach; it has a duct which carries its secretion into the beginning of the intestine, and that secretion acts powerfully upon all constituents of the food, digesting starch, meat, and fat. It was not supposed that the pancreas had any other function to perform. Animals can live without this secretion, and to a large extent can continue to digest and absorb their food much as before; for it has been possible to divert the secretion from the intestine and to collect it at the surface of the body; and it is found under these circumstances that, although the food is not quite so readily digested, nevertheless the animal does not materially suffer from the lack of the secretion. It was discovered, however, a few years ago (by v. Mering and Minkowski) that if, instead of merely diverting its secretion, the pancreas is bodily removed, the metabolic processes of the organism, and especially the metabolism of carbohydrates, are entirely deranged, the result being the production of permanent diabetes. But if even a very small part of the gland is left within the body, the carbohydrate metabolism remains unaltered, and there is no diabetes. The small portion of the organ which has been allowed to remain (and which need not even be left in its proper place, but may be transplanted under the skin or elsewhere) is sufficient, by the exchanges which go on between it and the blood generally, to prevent those serious consequences to the composition of the blood and the general constitution of the body which result from the complete removal of this organ. Now, some years ago it was noticed by Kuhne and Sheridan Lea that, besides its proper secreting structure composed of tubular alveoli, lined by granule containing cells, there are highly vascular patches of peculiar epithelium-like cells scattered here and there in the substance of the pancreas, which are wholly unconnected with the ducts and, so far as one can judge, with the secretion of the gland. We do not know anything whatever about the function of these patches, although from their vascularity it is extremely probable that they are not without importance physiologically, and

it is tempting to conjecture that it is these cells which are specially concerned in effecting that influence upon the metabolism of carbohydrates which experiment has shown to be peculiar to the pancreas.

The lesson to be drawn from these results is clear. There is no organ of the body, however small, however seemingly unimportant, which we can presume to neglect; for it may be as with the supra-renal capsules, the thyroid gland, and the pancreas, that the balance of assimilation and nutrition, upon the proper maintenance of which the health of the whole organism immediately depends, hinges upon the integrity of such obscure structures; and it is the maintenance of this balance which constitutes health, its disturbance, disease. Nor, on the other hand, dare we as the investigation of the attraction particle has shown, afford to disregard the most minute detail of structure of the body.—Prof. E. A. Schafer, British Association.

[From the American Medico-Surgical Bulletin.]

TEA AND ITS EFFECTS.

By James Wood, M.D., Visiting Physician to the Brooklyn Central Dispensary.

Excessive tea drinking is fast becoming a greater evil in this country than it ever has been in England and Ireland, the countries most noted for this indulgence. People so easily fall into the habit of using this form of stimulant that they are surprised when the physician calls their attention to the fact that they are drinking too freely. It is generally thought to be so harmless that it has become almost a household drink in many families, and in consequence the use is steadily increasing. It is, indeed, a very frequent occurrence to find one member of the profession advising patients to use tea and another immediately prohibiting its use. This procedure testifies most strongly to a want of some definite knowledge of the subject, and consequently there is no principle for guiding the course to be taken. What result this condition of affairs has had upon the limitation of the use of tea is well illustrated in the increasing demand and consumption in this country.

In 1890 there were imported into the United States 83,494,956 pounds of tea, an appreciable increase over the previous decade, and giving an allowance of 1⅓ pounds to each individual—truly a surprising quantity.

Some there are who deny that "theinism" is a common condition. In reply, the statement is made that, since January 1, 1894, of 1,000 patients applying for treatment, 100 gave such symptoms in the general examination as to point directly to tea inebriation. How many suffered from a similar condition, but applying for treatment for such diseases that did not necessitate going into a history of their daily customs, were addicted to the same habit, it is hard to state. The estimate is made that at least 50 per cent. drank the infusion to a greater or less extent. Here, then, we have clinical data of a cause for 10 per cent. of the ordinary derangements which one meets in general practice, especially in our large cities. Surely the importance of the question merits a careful study of tea and its effects upon the system.

There seems to be a very wide divergence in the results of different authorities in the analytic examination of the tea leaf or of an infusion of the same. Probably the best representative analysis is as follows:

Theine*	2·8 per cent.
Albuminoid principles†	3·5 " "
Carbohydrate elements‡	9·0 " "
Tannic acid§	14·2 " "
Essential oil	0·75 " "
Cellulose	23·0 " "
Water	0 " "

These are considered the principal constituents of the tea leaf, but besides the ones already mentioned, we have others, such as wax, resin, extractives of different kinds, salts, xanthine, hypoxanthine,‖ boheic acid and apo-theine. From this extensive list of constituents we might with justice consider the tea leaf a very complex body. However, there are but few of value either from a dietetic or scientific standpoint. Those which we shall consider are theine, tannic acid and the essential oil.

Tea is usually used in the form of an infusion—very often it is a pure decoction made from the leaves, and the action which it has on the human organism is as the sum of the effects of the three important constituents named above. The theine affects directly the nervous system primarily and the organic system secondarily; the tannic acid affects the digestive apparatus and such organs as are intimately connected with it; while the essential oil gives us the peculiar intoxication so typical of tea dipsomania. The natural order of study of this commodity, and the effects of its use, would be to consider at this point the infusion of tea. Tea is usually taken in this form by the people at large. The length of time of the infusion will greatly change, not only its composition, but influence almost entirely its action upon the system imbibing the same. A good example of this is found in the following table¶ of the difference in the amount of tannin taken up in a three and fifteen minute infusion:

	Finest Assam. Per Cent.	Finest China. Per Cent.	Common Congou. Per Cent.
Infusion for 3 mins. yielded	11·30	6·77	9·37
Infusion for 15 mins. yielded	17·73	7·96	11·15

It will be seen from this table that in an infusion of fifteen minutes of the finest Assam (Indian) tea, the yield of tannin is nearly two and a half times as much as the finest China. In all of the different teas we find the length of time of the infusion affecting greatly the composition, with possibly an exception in the case of the better qualities of China tea. About six-sevenths of the entire soluble matter—33 per cent.*—of the tea leaf can be incorporated in the first infusion. Again the authorities differ † greatly, but the above per centage will be found to be that most often met with in teas in common use in this country. Of the total amount of nitrogenous substances, 47 per cent. ‡ is soluble and is present in the infusion. The amount of tannin will range from 7 to 11 per cent., differing in the kind of tea. The amount of essential oil is about 0·75 per cent., and is present in larger quantities in the first infusion than in subsequent ones, and if the tea is not drunk immediately, it is soon lost. This is well illustrated in the frequent headaches complained of by professional tea tasters, who use the infusion immediately after it is made. Thus much for the constituents of the infusion.

The amount of tea which can be drunk every twenty-four hours with impunity differs with the individual. Some people are profoundly intoxicated by indulging in two cups of strong tea per day, while cases have come under my observation where 15 pints of the strongest were taken every day with very little damaging effects. Usually we find that an ounce of tea leaves used daily will soon produce poisonous symptoms. This amount would contain from 6 to 10 grains of theine.

The question might very properly be asked: What are the functions of the body disturbed by drinking tea, and what prominent symptoms are most often present?

ANALYSIS OF SYMPTOMS IN 100 CASES OF THEINISM.

Sex: 69 per cent. female; 31 per cent. male. Quantity: 2 pints or less, 54 per cent.; 4 pints or less, 37 per cent.; 10 pints or less, 9 per cent. Strength: 77 per cent., strong; 15 per cent., ordinary; 8 per cent., not known. Number nervous: 72 per cent. Bowels: 40 per cent., constipation; 2 per cent., diarrhœa; 15 per cent., irregular. Pains: 16 per cent., general; 10 per cent., heart; 9 per cent., back; 6 per cent., side; 7 per cent., chest. Dizziness, 20 per cent.; faintness, 8 per cent.; gastric and intestinal indigestion, 19 per cent.; intestinal catarrh, 8 per cent.; dreams, 5 per cent; "nightmare," 5 per cent.; depression, 10 per cent.; despondent, 20 per cent.; excited, 5 per cent.; suicide, 3 per cent.; headache, 45 per cent.; rheumatism, 5 per cent.; irregular menses, 12 per cent.; palpitation, 19 per cent.; muscular tremor, 12 per cent.; insomnia, 15 per cent.; anæmia, 6 per cent.; dyspnœa, 5 per cent.

In subsequent cases careful study is being made of the irregular cardiac action, hallucinations, nightmares, successive dreams, obstinate neuralgia, anxiety, a persistent, sinking sensation in the epigastrium, prostration, and general weakness, excitement and mental depression. These are more or less present in nearly all cases of tea intoxication, and are often the symptoms for the relief of which the patient seeks medical advice. Certainly comment on the table is hardly necessary; it bears silent but impressive witness.

In the abuse of this drink we have the ætiological factor either direct or indirect for nearly 50 per cent. of the headaches, one-fifth of the cases of dizziness, and the same percentage of despondency and palpitation of the heart. Truly an agent capable of so strongly affecting the human organism is worthy of more than passing attention.

The effects of tea drinking on the digestive organs is very pronounced. In a large number of cases, it is the active agent in the production of constipation, in others an alternating constipation and diarrhœa, and in some an intestinal catarrh. Some patients after drinking tea give a history of severe abdominal pains accompanied with nausea, and the action of the bowels greatly diminished.

These or any of the effects which tea has on the digestive system are largely due to the astringent action of the tannin.

Schwann § has shown that tannin will throw down a precipitate from artificial digestive fluids and render them inert. What else can we expect but deranged digestive action when people will indulge in copious draughts of strong tea before, during, and after each meal and often nearly every hour in the day?

Let us now consider the principal constituents of the infusion of tea separately that we may better appreciate the latent power which they contain. The theine is probably the most important of them all, and yet what changes this nitrogenous body undergoes in the system is still uncertain. We know that the end products, like those found after the metamorphosis of any nitrogenous body, are undoubtedly urea, uric acid, creatinine, water and carbonic acid, but what intermediate changes have occurred before the final results are reached is unknown. If it is oxidized artificially, we have as the result methylamine (CH_5N), hydrocyanic acid (HCN), and amalic acid ($C_{12}H_{17}N_4O_7$).

Theine lessens the tissue metamorphosis to a considerable extent,‖ as we find a decrease in the amount of carbon dioxide expired. If theine is pushed until we get its full physiological effects, we have a general excitement of the circulation with rapid pulse, muscular tremor, and a very urgent wish to empty the bladder. The imaginative faculties are more acute or the mind may wander, hallucinations and visions make their appearance, and a peculiar form of intoxication supervenes. These symptoms end after a long period of wakefulness in a deep sleep from exhaustion. Theine seems to affect chiefly the sensory system, but, in large doses, it may cause spasms and convulsions. The peculiar rhythmical contraction which we find in the voluntary muscular fibers and lasting for a considerable period, often several hours, acts transversely across the fiber, because we find that it is elongated at each contraction. Hypodermatic injections of theine acting on the sensory system produce local anæsthesia at the point where the needle was inserted, and for some distance below, thus having an efferent action along the nerve trunk. It is not narcotic.

Of the 47 per cent. of nitrogenous substances little of value can be said. Traces of xanthine and hypoxanthine were found by Baginsky, and these bear the same relation to similar if not identical bodies which we find in the extract made from muscular tissue; and they undoubtedly occur as the result of a like process, namely, a retrograde metamorphosis of nitrogenous elements.*

The amount of nitrogenous elements which is available for nutrition is manifestly too small to be of any value and additionally it exerts little if any influence in the chemico-physiologic changes by virtue of which vital force is produced. The arguments which certain individuals bring forth to substantiate its high sounding claim as a valuable addition to our list of food stuffs are truly amphigoric.

The next most important constituent of tea is the essential oil. This oil gives the aroma to the tea in a properly prepared infusion. Johnson† is skeptical about its existence before the roasting and drying process has been completed, and thinks it is produced during this procedure. It is found more plentifully in the green tea, and seems to be lost during the greater oxidizing process through which the leaves are put in order to produce the black variety. Physiologically it exerts a stimulating and intoxicating effect which is so powerful that the natives do not use tea until it is at least a year old. This alone is the narcotic agent found in the tea leaf and infusion. The amount usually found will average about 1 per cent.

Mention has been made of a difference existing between the black and green varieties of tea. The green tea is richer than the black in theine, essential oil, and tannin, and all the constituents soluble in water by fully 5 per cent.‡ The influence which the green tea has on the nervous system, and for which it is largely noted, is due to one of the above named constituents—the essential oil. Among the better class of people who drink tea, and can afford the better varieties, the black is given the preference, because it is less astringent and exerts less influence on the nerves. The poorer classes, in Ireland especially, use the Indian (Assam) and cheaper varieties, and cannot avoid the deleterious effects which the better class escape.

Next to the effects of tea on the nervous system the digestive organs are most often deranged functionally. In many cases the so-called infusion of tea is nothing more or less than a very strong decoction, and its contact with secreting and excreting surfaces must result in harm. If tea is imbibed too soon after a meal is taken, the digestive action will be seriously disturbed and hindered. The condition is not to be wondered at when we are aware of the ease with which the active agents of the digestive juices are precipitated and rendered inert by the tannin, or tannic acid, always present in the infusion or decoction. A very persisting gastric disturbance is often excited and maintained, which is positively non-responsive to any medicinal remedy and is only relieved by a total abstinence from the use of tea. In a large percentage of tea inebriates, as can be seen from the analysis given, the action of the bowels is greatly diminished, nausea is common, and very distressing abdominal pains are present. The nerve ganglia of the solar plexus are in an irritable condition, and a sinking feeling in the epigastrium is much complained of.

This description of the effects of tea on the nervous system and digestive apparatus is necessarily brief. To elaborate the different effects noted in those who indulge too freely, would be to narrate most of the common complaints suffered by humanity. In reports just received from institutions for the insane in Ireland great prominence is given to the immoderate use of tea as a causative factor in insanity.

The use of tea by the two sexes is a very interesting study. In the table of the 100 cases reported, 69 females were inebriates, while only 31 were of the male sex. This difference is often greater, especially among the poorer classes in our cities. Why this difference between the sexes exists is probably explained by the greater use of tobacco by men and the consequent satisfaction for a stimulant. Women assuage the importunities of the system for a stimulant by tea.

Undoubtedly the primal cause of the use of stimulants is poor health. Excessive labor, insufficient and unhygienic sleep, improper and an inadequate amount of nutrition extending over a long period, possibly years, creates the best possible condition which calls for stimulants.

It is hardly within the province of this article to discuss the relation of tea drinking to poverty, general perverseness, and other economic factors; these are reserved for future narration.

The relative position of theine among other stimulants is interesting, as we may thereby the more readily appreciate the power which this drug—for we may with justice so class it—is capable of exerting.

Theine and digitalis exert certain physiological actions in common. In toxic doses reflex action is lowered, especially of the nasal mucous membrane, by exciting Setschenow's inhibitory center. Both cause prostration, muscular tremor and often convulsions. They are mildly diuretic and diminish urea and uric acid. They cause nausea, vertigo, and abdominal pains. They are antagonized by opium.

The contrast between theine and caffeine is of still greater interest, as a large amount of so-called caffeine is made from old tea leaves, and is nothing more than theine. Is it then to be wondered at that some of the caffeine found in our shops proves of so little value?

While theine and caffeine are diametrically opposite in their action on the system, they are similar in producing cerebral excitement, wakefulness, hallucinations, and a soporific state following the exhaustion of insomnia. It is very apparent from our study of tea, and its principal constituents, that we have an agent of great power—one capable of producing the most detrimental effects on the system.

A fact has been noted among those tea inebriates who also drink coffee which is in support of the above statement. There are a considerable number of people

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* Konzi says 3·3 per cent.; Muller, 0·65 per cent.; Peligot, 3 per cent.; Stenhouse, 2 per cent.; Bauer, 1·3 per cent.; Parkes, 1·8 per cent.

† Konzi says 5·9 per cent.; Muller, 3 per cent.; Bauer, 9·4 per cent.; Parkes, 2·6 per cent.

‡ Parkes, 10 per cent.

§ White, 7·17 per cent.; Parkes, 15 per cent.; Konzi, 10 per cent.

‖ Baginsky, Zt. fur Physiol., 1885; vol. viii., p. 305.

¶ Dr. Hale White, Brit. Med. Jour., January 12, 1889.

* Pavy, Bauer, and Peligot.

† Soc. of Pub. Analysts of Eng. says 30 per cent.; Muller, 45 per cent.; J. Lehman, 15 per cent.

‡ Parkes.

§ Quoted by Muller in his "Elements of Phys." See Baly's trans., p. 516.

‖ Dr. Edward Smith, Phil. Trans.

* See Table II. in author's article: "The Pathology and Rational Treatment of the Uric Acid Condition." Merck's Bulletin, May, 1892.

† "Chemistry of Common Life," vol. i., page 170.

‡ Yeo.

who indulge very freely in both coffee and tea, and it is often difficult to determine which is producing the poisonous effects.

Attention is called to the following table of the comparative actions of the two drugs:

THEINE.	CAFFEINE.
Affects sensory system.	Motor.
Produces neuralgia.	Does not.
Causes spasms.	Does so late, if at all.
Causes convulsions.	Does so late, if at all.
Impairs or abolishes nasal reflex.	Does so late, if at all.
Diminishes temperature.	Increases.
Is astringent.	Is relaxing.
Dilates capillaries of splanchnic arcade.	Contracts the same.
Mildly diuretic.	Is powerfully so.
Causes irregular and feeble cardiac action.	Causes strong and regular.
Causes sinking sensation in epigastrium.	Relieves the same.
Causes sick headache.	Relieves the same
Opposes active nutrition.	Increases nutrition and tone of system.

When we endeavor to make a diagnosis by exclusions aided by the table already given, the difficulty is even greater. Caffeine and theine do undoubtedly antagonize each other, or rather, the symptoms which each are likely to produce alone are not present when the two are used in conjunction with each other. This was first noticed in some few patients who could drink large quantities of both tea and coffee and be but slightly affected thereby. They, however, complained the most of insomnia and cerebral excitement and of almost no other symptom. The study of the action of these two drugs in the system at the same time was one of the most interesting phases of our investigation of tea intoxication and gave the idea for the employment of caffeine in the treatment of this condition—a procedure which has given the best results.

It is a question whether theine represents any physiological action worthy of a place as a therapeutic agent. It has been used hyperdomatically in a few cases of sciatica, but with uncertain results. That its constant administration either in the uncombined form or in conjunction with other bodies, as for instance in the infusion or decoction of tea, is followed by undesirable effects on the system is undeniable. The pernicious influence on the organism which our study of tea has brought to light, and with its increasing use, should not be lightly treated, but an effort made to educate the people as to the danger of using it. Tea is one of the principal articles given to the poor by the charitable societies of some churches, and is a factor, therefore, of some importance in producing the increase of sickness among these unfortunates.

Brooklyn, N. Y.; 162 St. John's Place.

[FROM POPULAR ASTRONOMY.]

THE SPECTROSCOPE AND SOME OF ITS APPLICATIONS.

By J. E. KEELER.

THE SPECTRA OF THE ELEMENTS.

LET us suppose that we are repeating Kirchhoff's famous experiment. We place in front of the slit a calcium light and observe that the spectrum is perfectly continuous, no lines of any kind being visible. We now introduce a sodium flame, such as we have used in former experiments, between the incandescent lime and the slit, and find that the spectrum is crossed by two dark lines in the yellow, at exactly the same places where the bright lines of the sodium flame appear when the calcium light is removed; in other respects its appearance is unchanged. It appears, then, from this experiment, that the sodium flame is transparent to nearly all kinds of light, but that it is partially opaque to light of the same kind that it emits. It should be borne in mind that the dark lines are only relatively dark. The brightness of the sodium flame can in no way be diminished by placing the calcium light behind it; indeed, since the flame is partially transparent to its own kind of light, the dark lines are really brighter than the bright lines which are seen when the flame alone is in front of the slit. They appear dark by contrast, as the sun spots appear dark by contrast with the more brilliant photosphere. The flame stops more light of these two wave lengths from the incandescent lime than it emits. If the calcium light is dimmed, the dark lines become weaker, than vanish, and finally become bright on a less luminous continuous background.

Thus we see that the rays which a vapor readily emits are those which it strongly absorbs. If its emission is increased by raising its temperature, the absorptive power is increased in the same proportion. In order that the lines of a gas may be "reversed," i. e., appear dark on a bright background, the temperature of the gas must be lower than that of the source which yields the continuous spectrum. The natural law which underlies all these phenomena was thus formulated by Kirchhoff: "The relation between the power of emission and the power of absorption for rays of the same wave length is constant for all bodies at the same temperature."

The strong absorptive action of sodium vapor on light given out by sodium vapor at a higher temperature can be shown by a simple experiment, which does not require elaborate apparatus, or even a spectroscope. If we place a bead of any common sodium salt in the flame of a Bunsen burner, so as to obtain a sodium flame as bright and hot as possible, and then hold in front of it the feebly luminous sodium flame of a spirit lamp, the latter will be outlined as a dark flame on the bright background of the flame of the Bunsen burner, although the difference of temperature in this case is not great enough to make the experiment a very striking one.

Many experiments of this kind have led to the following laws, by which we are enabled to interpret the appearances seen in the spectroscope. 1. A solid or liquid (or a sufficiently compressed gaseous body) when heated to incandescence gives a continuous spectrum. 2. A luminous gas under small pressure gives a bright line spectrum. 3. An incandescent body whose light has passed through a gas having a lower temperature than itself gives a continuous spectrum crossed by dark lines, which occupy the same positions as the bright lines in the radiation spectrum of the gas.

These laws, which were determined by experiment, have a special significance when considered in connection with the kinetic theory of gases. According to this theory, the molecules of a gas are flying about in all directions with great velocity, continually colliding with one another, or with the walls of the vessel which contains them. If the interval between the collisions is comparatively large, the constituent atoms of a molecule can vibrate freely, in periods which are determined by their nature and by the way in which they are combined. To such vibrations are due the bright lines in the spectrum of a rarefied gas. If, on the other hand, the molecules are practically in contact as in a solid or liquid body or a gaseous body greatly compressed, the atoms no longer have a chance to execute their characteristic vibrations, waves of every length are communicated to the ether, and the resulting spectrum is continuous. The nature of the relation between absorption and emission is also readily understood. Just as one tuning fork takes up the vibrations transmitted to it by the air from another tuning fork, when both forks are in unison, but cannot do so if their periods are different, so an atom can take up the vibrations of the ether which synchronize with its own period, and thus deaden their intensity in the original direction, while it allows all other ether waves to pass unaffected. As both light and sound are the result of wave motions in an elastic medium, we can generally find analogous phenomena in optics and acoustics. Such comparisons are very instructive, but it should be remembered that no analogies can be expected for such phenomena as depend upon the direction of the vibrations, as this is different in the two cases; the vibrations of light being transverse and those of sound longitudinal, or in the direction of propagation.

All these remarks would not, perhaps, be much to the point, if the spectroscope were still regarded as primarily an instrument of chemical analysis. It was thus considered by the pioneers of spectroscopy; but modern investigations have wandered farther and farther from the path that it was once supposed they would follow, and the interest which attaches to the study of the spectrum is now physical rather than chemical. By the chemist the spectroscope is almost unused; but the physicist has recognized the fact that the lines of the spectrum are the direct language of the atom and the molecule, and strange hieroglyphics as they are, he still manages to make out a part of the wonderful story which they tell. From this point of view we shall regard the spectra of the elements, in considering them more closely; for the purposes of chemical analysis a mere catalogue of the characteristic lines would be sufficient.

It was once supposed that each element had its characteristic spectrum, which remained the same under all circumstances, and the simplicity of this view so commended itself to observers that the fact brought out by later investigations that the same element can have several entirely different spectra was accepted with some reluctance. In some cases the number of different spectra is considerable; thus no less than five different spectra of oxygen are known. The changes mainly result from differences of temperature, and are undoubtedly the result of changes in the molecular structure of the element. It is reasonable to suppose that a complex molecular structure is attended by a complicated spectrum, and a simple molecular structure by a simple spectrum. On testing this view by experiment we find that the evidence of the spectroscope is generally in harmony with the teachings of chemistry, although there are some exceptions.

If we examine the different elements with our spectroscope, we find the greatest diversity of spectra imaginable. Some spectra consist of but a few lines, and are obtained with the greatest ease; others contain many lines, sometimes distributed apparently at random and sometimes in pairs or groups with exquisite precision. The yellow lines of sodium are obtained with extraordinary facility—in fact, it is difficult to obtain a spectrum in which they do not appear—while some metals are vaporized with such difficulty that their spectra are obtained only with the aid of the electric spark.

As an instance of a sudden and complete change of spectrum we may take the case of the element nitrogen. When the ordinary spark from an induction coil is passed through a tube containing rarefied nitrogen, a beautiful fluted spectrum is seen consisting of a series of bands, each of which is bright and sharply defined on one side and fades away on the other. If, however, a Leyden jar is connected with the coil so as to intensify the spark, the fluted spectrum vanishes, and in its place appears a spectrum of bright lines, superposed on a faint continuous spectrum, which increases in brightness with augmented pressure. There is no indication in the appearance of the spectra that they belong to the same substance.

In some of the metals a gradual change takes place with increasing temperature; some of the lines brighten rapidly and new lines appear, and although the spectra at extremes of temperature are quite different in appearance, all the intermediate steps of the process of transformation can be traced. In some cases the total change is not great. Iron has a spectrum containing hundreds of lines, which are nearly the same at different temperatures, the changes of relative brightness being comparatively small. It is hardly necessary to point out that all these changes are of great importance in their bearing on celestial spectroscopy.

The characteristic lines of an element are the lines which are strong and persistent through a great range of temperature. As the emission of the substance is strong for these wave lengths at a low temperature, its absorption is also strong under the same circumstances, and hence these lines are easily reversed.

I have already mentioned those spectra in which the lines are rhythmically ordered, evidently in accordance with some physical law which governs the vibrations of the atoms of the substance. On account of the importance of the inquiry to molecular physics, much attention has been given to the numerical relations of the wave lengths in such a series of lines, with a view to discovering the law of atomic vibration, and many facts of the highest interest have been brought out. The idea which first naturally suggests itself is that the lines are analogous to the overtones of a musical note, like those which are produced by a vibrating cord harmonically divided; but an examination of the rates of vibration corresponding to the lines does not bear out this view. Indeed, as Kayser and Runge remark, the atomic vibrations rather resemble those of a plate or three-dimensional body than those of a stretched cord.

As the simplest example of a spectrum with rythmically ordered lines, let us consider the spectrum of hydrogen. The positions of five lines of the series are given in the figure representing the solar spectrum in the third number of Popular Astronomy.* If the reader will plat the lines C, F, Hγ, h and H on a separate slip of paper, or make them stronger on the map, he will see that the intervals between the lines progressively diminish in going toward the violet end of the spectrum. On the map the spacing of the lines is affected by the changing dispersion of the prism, and the rapid diminution of the intervals can be seen still better by platting the lines on the wave length scale. The series extends, however, beyond the limits of the map, and it is an interesting fact, showing the dependence of one science on another, that these upper lines were first discovered in the spectra of the stars, and afterward obtained with terrestrial hydrogen. In some stars the sixteenth line of the series has been photographed, and at this point the interval between the lines is reduced to only six tenth-meters. A simple formula representing the wave lengths of the lines in the hydrogen series with great exactness has been given by Balmer.

The metals of the alkalies are especially suitable for spectroscopic investigation, first, because the chemical properties of these elements are well understood, and second, because the spectra are comparatively simple. The elements lithium, sodium, potassium, rubidium, and cæsium form a well known group, characterized by strikingly similar chemical properties which follow in degree the sequence of the elements as given in the list. It is therefore interesting to inquire whether these chemical relations are in any way represented by similarities of spectra.†

We may begin with sodium, whose spectrum under ordinary conditions is already familiar to us. At the temperature of the alcohol flame, the visible spectrum consists of a single pair of yellow lines, but at higher temperatures other lines appear, and these lines are also arranged in pairs; moreover, in the upper part of the spectrum, where the lines are least numerous, the pairs are arranged rhythmically, like the single lines in the spectrum of hydrogen, although from the appearance of the lower spectrum it is evident that several series are mingled together. It is not possible to pick out the lines of each series by the eye, where the lines are numerous, but by computing a formula from observations of the lines which are evidently arranged in series the other lines belonging to it can be identified. In this way it has been found that the sodium spectrum is made up of three superposed series of pairs.

On investigating the spectra of the other metals of the group, we find that similar relations obtain. The lines of lithium fall in three series, but they are apparently single; the sodium lines are, as we have seen, double; the potassium lines are more widely double, and so on down the list, the lines of the cæsium pairs being quite widely separated. It seems likely, therefore, that the lithium lines are also double, although the components are too close to be separated. In each element the lines of corresponding series are situated farther and farther toward the red, as we go down the list, until when we come to cæsium the lowest pair falls in the infra-red, where it cannot be seen; its place can, however, be calculated by the formula, and Professor Snow has actually found the lines, by their heating effect, as nearly in their calculated places as one could expect when the difficulty of the observations is considered.

That the lines of a series should satisfy a mathematical formula is a sufficiently striking proof that they are closely related in fact, but when we examine carefully the lines of any one series, we find a close family resemblance which shows beyond all doubt that they really belong together, and in all probability have their origin in the vibration of the same atom. To one series belong all the characteristic lines of the element, and for this reason it has been called the principal series; the lines of each subsidiary series have also special properties. In the case of lithium, the lines of the principal series are sharp and easily reversed; those of the first subordinate series are greatly widened on both sides when much lithium vapor is present, and are generally reversed; while the lines of the second subordinate series broaden on the lower side only and are never reversed. All the lithium lines are included in these three series. The sodium pairs fall in three series, with the exception of a pair at λ 5675·9 and λ 5670·4, which differs from all others in the character of the lines, which are diffuse on the upper side. It is very probably the only visible member of a fourth series.

The discovery of these series in the spectra of the elements is evidently of great importance to celestial spectroscopy. If, for instance, we suspect that a certain line in the spectrum of a star is due to potassium, we look for other lines belonging to the same series, and if they are absent, we may conclude that the apparent coincidence of the star line with the line of potassium is merely accidental. Again, we may ask why it is that of all the sodium lines which have been mentioned only two pairs are found in the solar spectrum. This is a question that we can now readily answer. The pairs referred to are the well known D lines and a pair of lines whose wave lengths are λ 3303·1 and λ 3302·5. Now these pairs both belong to the principal series, and they are the only lines of the series that fall where they can be recognized, the higher members being in the extreme ultra-violet among a great confusion of other dark lines. All the other sodium lines belong to the two secondary series. Their great tendency to widen indicates that molecules of some complexity, such as could exist only at comparatively low

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* The hydrogen line nearly coinciding with H of the solar spectrum is there erroneously called the fourth of the series; it is the fifth.

† Most of the information contained in the rest of this article has been gathered from the admirable memoirs of Professors Kayser and Runge, in the transactions of the Berlin Academy of Sciences.

temperatures, are concerned in their origin, and hence it is not surprising that they should fail to appear at the high temperature of the sun.

Space does not permit us to consider at length the spectra of other groups of elements. We find in them pairs, triplets, or other characteristic groups arranged according to a definite law, and also many lines which do not seem to be disposed systematically; but the lines whose spacing can be represented by a formula are generally the characteristic lines of the substance.

There is, however, one spectrum so remarkable that we must give it a little more than passing notice. Carbon is an element which is remarkable in chemistry for the vast number of compounds which it is capable of forming with other elements in consequence of its complex molecular structure. We might expect, therefore, to find its spectrum one of considerable complexity, and in this expectation we are certainly not disappointed. The spectrum, which consists of a number of bands whose sharp edges are turned toward the red, can be seen with a small instrument by holding the slit close to the blue flame of a Bunsen burner, but, of course, the spectrum obtained in this way is only a feeble one. By employing powerful apparatus, with the electric arc as a source of light, and especially by substituting the photographic plate for the eye of the observer, these feeble bands are resolved into fine lines, spaced with wonderful regularity. Toward the edges of the bands the lines are so closely packed that they can no longer be distinguished, and several sharp edges of inferior brightness are found in each band. Above the bright edges the lines become fainter and fainter, but, according to Kayser and Runge, they are still traceable, with sufficient exposure, until they meet the next band, so that no part of the spectrum is free from carbon lines, their total number being certainly over 10,000.

Let us examine more carefully one of these bands, say the one which begins at λ 3,883·5. This is a band which does not appear in the spectrum of a Bunsen burner, although it is strong in the spectrum of the electric arc. Beginning at the sharp edge of the band and passing up the spectrum, we find that the lines, which at first were too close to be separately distinguished, begin to draw apart, the interval between them increasing gradually and with perfect regularity. Farther on they become double; but before the series can be traced very far (perhaps for thirty lines), a second sharp edge sets in, and with this begins a second series just like the first, so that beyond the second edge two independent series of lines with different intervals are superposed. Still farther on a third series begins, and then a fourth and a fifth, the result being a wonderful confusion of lines, from which it is almost impossible, even with the aid of a formula, to pick out the lines of a given series. The other bands of the carbon spectrum have a quite similar structure, and some of them are still farther complicated by the occurrence of triplets in series, the intervals of the constituent lines and those of the groups varying progressively in accordance with some physical law.

Here I must close this imperfect account of the spectra of the elements. I have merely indicated the direction which recent spectroscopic investigations have taken. The facts already discovered are important, and promise still greater results in the future, for they have a direct bearing on the great problems of molecular physics.

I hope the beginner will not be disappointed when he finds that I have not told him how to recognize all the different elements by their spectra. The knowledge that will enable him to do this can be only in part obtained from books; the rest comes with long practice with the instrument. Lists containing the wave lengths of the lines in the different spectra are, of course, indispensable, and they may be found in Kayser's "Lehrbuch der Spektralanalyse" and in Watts' "Index of Spectra." The wave lengths, based on early measures with imperfect instruments, are not very reliable, but they are sufficiently accurate for ordinary purposes. A list of standard lines whose wave lengths have been determined with extreme precision has been published by Professor Rowland, and the more extensive lists of Professors Kayser and Runge are of nearly equal accuracy.

The pioneer observer, Lecoq de Boisbaudran, published a book called "Spectres Lumineux," in two volumes, in 1874. One volume contains descriptive text and the other beautifully engraved plates, representing different spectra as seen with an instrument of small dispersion. This book is very useful to possessors of small instruments, but I do not know how easily it can be obtained at present.

The spectra of most of the elements cannot be well exhibited without somewhat elaborate apparatus, but the characteristic lines of sodium, lithium, potassium, strontium, thallium, rubidium, and others, are readily obtained by placing salts of these metals in the flame of a Bunsen burner. The spectrum of an ordinary arc light contains many bright lines, due to the metals present as impurities in the carbons. A beautiful fluted absorption spectrum is obtained by placing a few grains of iodine in a heated bottle held between the slit of a spectroscope and a bright lamp flame. An examination of these spectra will afford much pleasure and profit to the beginner.

ANTIMONY AND BISMUTH IN BOLIVIA.

THE consul-general of France at La Paz, in Bolivia, has recently made a special report on the mines of bismuth and antimony in that country. The only deposit of bismuth ore actually known is that of Quechisla (also known as Choroloque), though some exploration for others has been made, but without success. The returns show that the production of this mine is about 500 Spanish quintals, or 23,000 kilos., per month. This production, however, is regulated in concert with the European producers. In addition to bismuth the Quechisla mine yields some tin and a little silver.

Antimony is found in many places in the department of Potosi, generally in connection with gold and silver ores. In the province of Chayantla there are many veins of the sulphuret of antimony, which have become more accessible than formerly since the building of the Antofagasta Railroad. Owing to the present low price of the metal, however, it does not pay to work the poorer deposits. The Amayapampa Company, a recently formed Bolivian corporation, is now producing and exporting 100 metric tons a month of 65 per cent. ore. The mine is 18 miles from the railroad, over a difficult mountain trail. With better transportation the output could be largely increased. It is said, however, that all the veins so far found diminish in richness with depth. The industry is just beginning in Bolivia, and the government has freed the producers from all direct tax and also from export duty.

THE ANTWERP EXHIBITION.

THE most original and interesting "side show" of the Antwerp Exhibition is to be found beyond its precincts. The mimic village in the shadow of the classical picture gallery, with its lake, huts and palm trees, has doubtless been arranged with considerable skill, but if you would see its temporary inhabitants au naturel you must visit them in their camp hidden away amid the glacis of the first zone of the fortifications, where Mr. Fernand de Meuse reigns supreme over a veritable imperium in imperio. Every night and morning he marshals the picturesque but somewhat noisy procession of African warriors and women which twice daily traverses the Exhibition ground on its way to Bona on the Scheldt. It is difficult to believe that the soft-spoken, mild-mannered young man who welcomes you so courteously to his dominions wields supreme power over sixty or seventy savages, nine-tenths of whom, under ordinary circumstances, would be ready, not only to kill, but to eat him.

Fernand de Meuse has only just attained his thirtieth year. It was in 1885 that he first went out to the Congo in the capacity of a botanical student. He returned to Belgium in the following summer, but after four months' leave he devoted three years to the exploration of the whole of the watershed of the Upper Congo, studying every variety of native dialect, and making himself master of all the details of African life. 1889 saw him once more in Belgium, but in 1890 he undertook the task of carrying out a commercial and geographical survey of Lake Leopold II. and the Lokenye River. He gave the first indications of the existence of a great lake called Kouronki, the shores of which have not yet been reached by a white man. On the death of M. Delcommune he became acting director of the Upper Congo Company. He brought back with him to Europe rich collections of botanical, mineralogical, geological and ethnographical specimens. He has also visited the French and Portuguese Congos. Fernand de Meuse has probably covered more ground than any other explorer. He is completely master of eight Congolese languages, and exercises an almost magnetic influence upon every native with whom he comes in contact. He never fights or uses arms, except when absolutely necessary, but has more than once given proof of coolness and courage under circumstances of extreme danger. He bears on his body the scars of both gun and arrow wounds. Fernand de Meuse enjoys the confidence and esteem alike of the king, the Congo State Government, and the Congo Commercial Companies.

The moment you appear with M. De Meuse at the entrance of the camp, you are surrounded by a crowd of laughing, inquisitive natives, many of whom have some petition to prefer or question to ask. The majority of his swarthy subjects are crouching before wood and coke fires at the door of their black and yellow huts, for they feel very acutely the dampness of the wettest August on record. M. De Meuse knows every man by name, and can tell you all about the peculiarities of his tribe. You are introduced in succession to the Zongo and the Trodzo, the skin of whose foreheads has been cut into ridges resembling a cock's comb and whose shark-like teeth denote cannibal propensities. Some have the lobes of their ears disfigured in a similar manner, and M. De Meuse shows you the essential differences in the teeth of various tribesmen. Here is Undeko, a Mongo woman with her body seared and scared all over; next her sits Buycko, a Zongo lady with thousands of beads woven permanently into her hair, while her neighbor, a Wangata, from the equator, wears a necklace of brass weighing just over ten pounds; M. De Meuse introduces you to his friend Adolphe Vandenboore, who has just returned from Africa, where he was commercial agent in the Upper Congo. The camp at Antwerp breaks up in two or three weeks' time, as the climate is already telling on the health of the sunshine-nurtured Africans. You visit the guard room, where a dozen stalwart warriors, dressed in blue jerseys with a yellow star on the breast, are supping on rice.

M. De Meuse tells you that clay is also used as an article of food, and it is eaten with gusto by a gentleman who has contrived to introduce five pieces of rope into his ear, with no sort of discomfort! The blue flag of the Congo waves over the bakery; busts of the King and Queen of the Belgians adorn the barrack, and in the smithy a couple of sturdy non-cannibal Casais are busily engaged in hammering out a rude battle ax. Here you come across a very important personage indeed, to whom you are solemnly introduced. Ishwarboli, Chief of the Basokos, fought Stanley in 1887, but he looks peaceful enough now as he smokes a cigarette in a costume which ranges from a pot hat and gloves (the indication par excellence of noble birth in Darkest Africa) down to a necklace of shells, glass beads and tiger's teeth. Ishwarboli's ears, moreover, are swelled to three times their normal size by the addition of morsels of cord drawn through the flesh! In the hands of M. De Meuse even Ishwarboli is as wax. He consults him as to the advisability of adding one more wife to the five he already possesses. In the primitive Congo camp M. De Meuse is at once chief, chaplain, baptizer, medicine man, arbitrator, counselor, match maker, and friend. We shall probably hear of him in Europe some day as a famous discoverer or scientific author. In the mean time let those who desire to see the most unique and curious sight which the Antwerp Exhibition affords, get permission to see the leopard skin and blanket wearing denizens of M. De Meuse's little settlement at home. At one moment you verily believe yourself to be at the equator; the next you have climbed the grass slope of the fort, and standing by the Congo flag look down on the lazy Scheldt, the windmills, the grazing cattle and the reapers.—Belgian News.

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TABLE OF CONTENTS.

PAGE

I. AERONAUTICS.—A New German Military Balloon.—A new balloon free from oscillation for observations.—1 illustration 15607

II. ANTHROPOLOGY.—The Antwerp Exhibition.—Notes on the interesting exhibition of African natives in Antwerp 15622

III. ARCHITECTURE.—Methods of Constructing Chimney Flues and Pipes at Paris.—Systems of French building constructions described.—14 illustrations 15615

IV. CHEMISTRY.—A New Form of Air Bath.—By E. SAUER, Jour. Amer. Chem. Soc.—An air bath through which a current of hot air is caused to pass.—1 illustration 15618

Chemistry at the British Association.—A resume of the most interesting chemical features of the last meeting 15617

Dropping Flask for Standard Solutions.—By F. VAN DERPOEL.—A substitute for a burette, by which the solutions are weighed instead of measured.—1 illustration 15618

The Alkaloids of Cod Liver Oil.—Interesting notes on these curious substances.—4 illustrations 15618

The New Gas.—Possible discovery an allotropic form of nitrogen 15615

The Ptomaines Formed During Putrefaction.—By C. A. MITCHELL, B. A., Oxon.—The present aspect of the cadaveric alkaloid question 15616

V. ELECTRIC ENGINEERING.—Electric Transmission of Power for Mining Purposes.—French practice in the transmission of power by electricity 15610

VI. GEOLOGY.—On the Chemistry of Coal Formation.—By J. W. THOMAS, F. I. L.—Coal, its composition, and formation in past ages 15616

VII. MATHEMATICS.—An Approximate Method for Dividing Angles of Arcs.—By MAX LOWENTHAL.—An ingenious method of approximately trisecting the arc graphically.—2 illustrations 15613

VIII. MECHANICAL ENGINEERING.—High Speed Vertical Engines.—Double-acting engines for direct driving of dynamos 15611

The Influence of Circulation on Evaporative Efficiency of Water Tube Boilers.—By Mr. JOHN I. THORNYCROFT.—Interesting experiments on tubular boilers.—3 illustrations 15608

IX. METALLURGY.—Improvements in the Production of Chlorine and Refined Lead and Recovery of Silver.—By F. M. LYTE.—A new metallurgical process illustrated and described.—1 illustration 15618

X. MINING ENGINEERING.—Antimony and Bismuth in Bolivia.—Notes on the production of these metals in South America 15622

Flames in Foul Air.—Suggestions for the practical inspection of air in mines 15618

Methods of Mine Timbering.—By W. H. STOOKS, Assistant in the Field.—Overhand stoping.—Continuation of this profusely illustrated article, treating of overhand stoping and other practice.—10 illustrations 15620

XI. MISCELLANEOUS.—The Cholera in Russia.—Grand religious ceremony on the occasion of the visitation on Russia of the cholera.—1 illustration 15619

XII. NAVAL ENGINEERING.—The Automatic Steering Compass.—Notes on this most ingenious invention and the difficulties overcome in it 15611

The Italian Navy.—A new Italian built war ship the Etruria.—1 illustration 15611

XIII. PHOTOGRAPHY.—A Simple Enlarging Process.—A very simple apparatus for producing bromide enlargements 15614

Revolving Photographic Studio. A rotating photographic chamber for obtaining proper light effects.—1 illustration 15614

The Development of Gelatine Aristo Prints.—Manipulation and formula for this purpose 15614

XIV. PHYSICS.—The Spectroscope and Some of its Applications.—By J. E. KEELER.—The application of the spectroscope in science 15621

XV. PHYSIOLOGY AND HYGIENE.—Tea and its Effects.—By JAMES WOOD, M.D.—A very practical paper on the effects of tea on the system 15620

The Thyroid and the Pancreas.—An interesting investigation into the functions of these two organs, hitherto so little understood 15619

XVI. RAILROAD ENGINEERING.—High Speed on Railways.—By W. H. WESTON, M.E.—Locomotives and roadbeds as factors in railway speed 15607

Holding Power of Brakes at High Speed.—The laws of the friction of brakes on railroad wheels.—1 illustration 15609

XVII. SOCIOLOGY.—The Evolution of the Workshop.—By C. JOHN HEXAMER.—The trade associations of past ages and the future of the mechanic 15612

XVIII. TECHNOLOGY.—Refining of Carbon Bisulphide.—By J. FARBAKY.—Impurities of this substance and how they can be removed 15617

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